1

INTERFACE

Previous page: USAF photo by Senior Master Sgt. Rose Reynolds

Chapter 1

GENERAL INSTRUCTIONS

This chapter provides an overview of the *USAF* interface. This section gets you started and explains a few general features. The other major sections cover the following:

***Main Menu* Screen** (p. 1.3) details all of the features of the *Main Menu* screen, including *Fly Now*.

Flight Screens (p. 1.5) covers all of the screens where you can choose or create a mission to fly immediately.

Mission Screens (p. 1.15) describes all of the interface screens you see after you have loaded a mission.

Tools Screens (p. 1.26) talks about the *Pilot Records*, *Mission Recorder*, *Reference* and *Web* screens.

For information on setting up multiplayer games, see **Multiplayer, p. 5.1**.

For *Preference* screen options, see **Appendix D: Preferences Window**, p. 8.8.

Note: *Jane's USAF® has a primarily cursor-driven interface. Unless specified otherwise, "click" always refers to left-clicking the mouse.*

Getting Started

There are two ways to begin playing *Jane's USAF,* once you've installed the game. (For installation instructions, please see your *Jane's USAF Install Guide.*)

Jump directly into flight. If you want to jump directly into a random, computer-generated air-to-air battle, you will want to choose the *Fly Now* option.

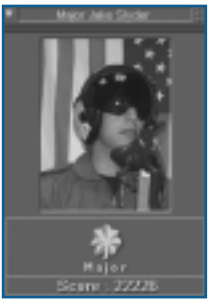
- Click the *USAF Fly Now* icon on your desktop.
- You will begin the mission in the cockpit. (For more information on *Fly Now*, see **Fly Now**, p. 1.4.)

Begin at an interface screen. If you want to begin at an interface screen, where you can choose missions, view your pilot records, etc. before you fly, you will want to choose the *Jane's USAF* option.

- Double-click the *Jane's USAF* shortcut icon on your desktop to start the game.

  — **OR** —
- Click **Start** on the *Windows 95/98* taskbar menu and then select **Programs > Jane's Combat Simulations > USAF > Play USAF** to start the game.
- You can bypass the introduction by pressing any key.
- You begin every *USAF* game from a *Main Menu* screen. You can disable the *Main Menu* by de-selecting the SHOW MAIN MENU checkbox on that screen. If you do so, the opening screen defaults to the last screen you visited.

Drop-Down Pilot Window



In the top right-hand corner of each screen is a button for a drop-down pilot window. The name displayed on the button is your currently selected pilot. Click on the button to view this pilot's current stats. Click again to close the window.

Go to the *Pilot Records* screen to view more in-depth information about the currently selected pilot, change his photo, select a different saved pilot or create a new pilot. See ***Pilot Records* Screen**, p. 1.26.

Menu Button

At the bottom of nearly every screen is a MENU button which gives you access to all of the interface screens. Click on an option to go to that screen.

Instant Action

Fly Now Jump straight into flight. See p. 1.4.

Flights

Quick Mission Create and fly a customized mission. See p. 1.5.

Training Fly a training mission. See p. 1. 8.

Single Mission Fly a pre-scripted, single mission, a mission you created, or a future campaign mission you've already won. See p. 1.9.

Campaigns Start or rejoin a campaign. See p. 1.10.

Multiplayer Start a multiplayer game. See **5: Multiplayer,** p. 5.1.

Tools

Pilot Records View pilot statistics and change pilots. See p. 1.26.

Mission Recorder Review recorded missions. See p. 1.33.

Reference Prepare with Jane's reference information. See p. 1.35.

Web Check out relevant web sites. See p. 1.36.

Preferences

Set graphics, sound, game controls, keyboard, and gameplay options. See **Appendix D: Preferences**, p.8.8, for full documentation of these features.

Main Menu

Return to the *Main Menu*. See p. 1.3.

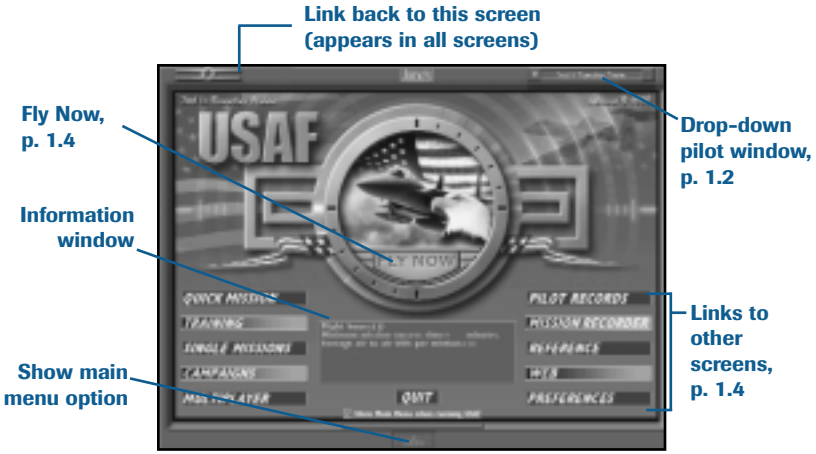
Quit

Exit the game.

MAIN MENU SCREEN

From the *Main Menu* screen, you can access all other interface screens and view data for your currently selected pilot.

To return to this menu from any other interface screen, click on the MENU button at the bottom of the screen and choose MAIN MENU. Or, click the link at the top of any pre-flight screen.



Show Main Menu Option

When the box marked SHOW MAIN MENU WHEN STARTING USAF at the bottom of the *Main Menu* screen is checked, you will begin at the *Main Menu* screen. This happens whenever you start the game using the *Jane's USAF* shortcut or choose *Play USAF* from the *Windows 95/98 Start* menu. If this box is unchecked and you enter in one of the ways listed above, you will begin the game where you left off. (You will always begin the game in the cockpit of a randomly generated mission when you click the *Fly Now* shortcut icon on your desktop.)

Information Window

When you run *Jane's USAF* for the first time, a customized welcome message appears in this box in the lower center of the screen. It recommends an initial mission type based on the gameplay level you selected during installation. When you subsequently return to this screen, your current pilot's stats appear in this window.

Whenever you position the cursor over a link on the screen, information about that link replaces the information in this window.

Fly Now

The large **FLY NOW** button in the center of the *Main Menu* screen takes you directly to the cockpit of one of the eight flyable aircraft, in the middle of an air-to-air scramble.

To get an idea of your situation, you can of course use all of the instruments normally available to you in the cockpit — such as your radar, RWR, etc. For a brush-up on instrumentation, see the **Cockpit** chapter, p. 2.1-2.48.

You can also take a look at the real-time *Tactical Display* screen by pressing Esc. This screen shows the movement of all friendly and enemy aircraft in each area, as well as relevant ground objects. You can zoom in on areas, object and flights, and click **VISIT** for a camera's-eye view of some objects. See *Tactical Display* screen, p. 1.15, for more details.

Note: *Fly Now missions do **not** count toward your currently selected pilot's kill tally, statistics, score and rank (see **Pilot Records** Screen, p. 1.26).*

Links to Other Screens

Move the mouse over a link to highlight it. A short description of the link appears in the information window in the lower center of the screen. Left-click on the link to go to the corresponding screen.

The page references below indicate where to turn in this manual for more information on each link.

FLIGHT SCREENS	*Quick Mission*	p. 1.5
	Training	p. 1.8
	Single Missions	p. 1.9
	Campaigns	p. 1.10
	Multiplayer	**Multiplayer**, p. 5.1
TOOL SCREENS	*Pilot Records*	p. 1.26
	Mission Recorder	p. 1.33
	Reference	p. 1.35
	Web	p. 1.36
	Preferences	**Appendix D**, p. 8.8
	Quit	Exit the game.

FLIGHT SCREENS

The flight screens allow you to choose or create a mission to load and fly. All are available from both the *Main Menu* screen and the MENU button at the bottom of all preflight screens (see ***Main Menu* Screen**, p. 1.3 and **MENU Button**, p. 1.2). Flight screens include:

Quick Mission Editor	Set basic mission parameters to create a custom mission that you can fly immediately.
Training (p. 1.8)	Fly a pre-scripted mission designed to teach you flight skills, weapons use or combat tactics.
Single Missions (p. 1.9)	Fly a pre-scripted, single mission, a mission you created, or a future campaign mission you've already won.
Campaigns (p. 1.10)	Fly a series of related missions.

You can also jump directly into a randomly generated air-to-air battle by clicking the **FLY NOW** button on the *Main Menu* Screen. See **Fly Now**, p. 1.4.

Quick Mission Editor Screen

The Quick Mission Editor allows you to quickly design a customized mission. You determine what goes into the mission, and the computer places all of the objects for you. Quick Missions will ***not*** count toward your currently selected pilot's kill tally, statistics, score, and rank (see ***Pilot Records* Screen**, p. 1.26).

Open a Quick Mission that you have previously created and saved using the Quick Mission Editor.

Save the current Quick Mission. You can later open this mission. Quick Mission files are saved by default in **Program Files\Jane's Combat Simulations\USAF\Resource\Missions\Qme**. (You can move these missions to any other computer, as long you copy them into this same directory.) Finally, you can access your Quick Mission by selecting **My Missions** from the Single Mission screen.

Have the computer generate Quick Mission Editor settings for you.

Load the Quick Mission you have created. A pop-up window appears, tracking the progress of the load; if you wish to cancel, click the **CANCEL** button to go back to the *Quick Mission Editor* screen. Once the mission is loaded, you will begin it from the *Tactical Display* screen (see p. 1.15).

Go back to the previous screen.

Mission Settings

You will set general parameters for your mission in the box on the left side of the screen. Note that Quick Missions are modeled on USAF Red Flag missions in that USAF pilots fly against each other on "red" and "blue" sides. You always start out on the blue side, leading the Austin flight.

Note: *In multiplayer games, you can switch sides before you fly by jumping into a red side flight. (Click the* CORVETTE *or* DODGE *flight button at the bottom Tactical Display screen — see* **Switching Aircraft/Flights**, *p. 1.21, for details.) Once you are in flight, however, you can't switch sides.*

Mission Name Type in a name for the mission. This name will appear under **My Missions** in the *Single Mission* screen.

For the following options, choose a setting from the pull-down menu:

Area VIETNAM, IRAQ, GRAND CANYON or GERMANY
(determines the terrain you will fly over)

Time of Day DAWN, DAY, DUSK or NIGHT

Starting Position HEAD-ON (both sides begin the mission facing each other)
TAIL-ON-BLUE (red begins the mission on blue's tail)
TAIL-ON-RED (blue begins the mission on red's tail)

Starting Range 5 MILES, 10 MILES, 20 MILES, OR 30 MILES
(Determines how far apart the red and blue forces are)

Weapons GUNS ONLY (loadouts limited to guns)
AA (default loadout consists of air-to-air weapons)
AG (default loadout consists of air-to-ground weapons)
AA & AG (default loadouts consist of air-to-air and air-to-ground weapons)

Note: *Guns are available in every loadout selection. Additionally, you can always use guns for either air-to-air or air-to-ground attacks. The options above limit only the missile and bomb ordnance loaded on aircraft.*

USAF A/G Target CONVOY, SAM SITE, RUNWAYS or NONE
(Establishes a ground target for the *blue* side)

Enemy SAMs 0, 1, 2 or 3
(Sets the number of SAM sites on the *red* side)

Enemy AAAs 0, 1, 2 or 3
(Sets the number of AAA sites on the *red* side)

Revivals

This sets the number of times aircraft on both the red and blue sides can regenerate. If you fly the blue side, the settings below apply to the red side. If you jump to the red side, the settings below apply to blue.

No. of Revivals 0, 1, 2, 3, or UNLIMITED

Revival Delay 0, 10 SECONDS, 20 SECONDS or 1 MINUTE

Weapon Reload CURRENT LOAD (plane regenerates with whatever weapons it had left when it was destroyed)
RELOAD ALL (plane regenerates with full, original loadout)

Mission Forces

In the box on the right side of the screen you will configure the flights for the blue and red sides. Each side has a maximum of two flights — Austin and Buick flights are always blue and Corvette and Dodge are always red.

You can set the following for each flight:

No. of Planes Click the menu to select the number of aircraft — 0 / 1 / 2 / 3 /4. The Austin flight must contain at least 1 aircraft. All other flights have a minimum of 0.

Aircraft F-16, F-16C, F-15C, F-15E, F-117A, F-4E, F-22A, A-10A, F-105D and MIG-16 through MIG-29.
(Scroll down the menu to see all available options. The blue side can fly any player-controllable aircraft, while the red side can fly any aircraft.)

Task CAP, CAS or STRIKE
(See **Tasking Section**, p. 1.18, for definitions.)

Starting Altitude RUNWAY, 1000 FT. AGL, 5000 FT. AGL, or 15000 FT. AGL.

Training Screen

Jane's USAF has a variety of training missions covering the basics of flying, air-to-air combat and air-to-ground combat. Training missions count toward your currently selected pilot's kill tally, statistics, score, and rank (see ***Pilot Records* Screen**, p. 1.26).

Choosing a Course

The training series is made up of three courses: *Basic*, *Weapons School* and *Red Flag*. Click on a training course in the upper right corner of the screen to select it. The currently selected course is highlighted.

BASIC. Covers basic flight skills — taking off, landing, refueling, and training.

WEAPONS SCHOOL. Provides hands-on experience with various weapons systems in different environments. These missions are based on the actual USAF Weapons School curriculum, and have been enhanced for this game.

RED FLAG. Red Flag is the Air Force's air combat training program. These training missions feature more advanced scenarios designed to prepare fighter pilots for grueling air-to-air combat. They are only available to pilots who have reached the rank of 1st Lieutenant. For more information on USAF's Red Flag program and its history, see **Background: Operation Red Arrow**, p. 6.24.

Flying a Mission

The *Missions* box on the left of the *Training* screen lists the missions available in the currently selected course. Click on a mission to select it. Information about the mission — including the mission objective, the flights participating in the mission and a map of the mission area — appears in the *About Mission* window in the center of the screen.

The *Planes* box on the right of the screen lists the aircraft that you can fly for the selected mission. Click on an aircraft to select it.

LOAD — Once you have selected your mission and plane, click **LOAD** to load the mission and display the *Tactical Display Screen* (see p. 1. 15).

BACK — Go back to the previous screen.

Single Missions Screen

Single missions include:

- Several pre-scripted single missions that are not part of any campaign
- Missions you have already completed in one of the futuristic campaigns (Operation Red Arrow and Operation Sleeping Giant)
- Missions you've created and saved with the Quick Mission Editor (p. 1.5) or User Mission Editor (UME). (See **Start > Program > User Mission Editor (UME) Manual**.)

Listing Available Missions

The text options in the top right corner of the screen control which missions are displayed in the Missions box on the left. The currently selected option is highlighted in light blue.

ALL. List all available single missions. (None count toward campaign outcomes, some count toward currently selected pilot's record — see SINGLE below.)

SINGLE. List single missions that are not part of any campaign. These are the only missions that count toward your currently selected pilot's record (i.e., kill tally, statistics, score and rank).

OPERATION RED ARROW. As you complete missions in this campaign, they become available on this screen so that you can refly them. (None count toward campaign outcome or pilot's record.)

OPERATION SLEEPING GIANT. As you complete missions in this campaign, they become available on this screen so that you can refly them. (None count toward campaign outcome or pilot's record.)

MY MISSIONS. List of missions you designed and saved using the Quick Mission Editor (see p 1.5) or User Mission Editor (see **Start > Program > User Mission Editor (UME) Manual**). None count toward pilot's record.

Important Note: *Most single missions flown from this screen do not count toward your currently selected pilot's record (i.e., kill tally, statistics, score and rank). The exceptions are standalone single missions that are not also a part of any campaign (see notes above). Likewise, missions that are also part of campaigns do not count toward the outcome of the campaign when flown from this screen as single missions. Missions you've created with the Quick Mission Editor or User Mission Editor will not affect pilot statistics.*

For more information on what counts toward a pilot's record, see **Pilot Records Screen**, *p. 1.26.*

Choosing a Mission

Click on a mission in the *Missions* box on the left side of the screen to select it. (Use the scroll bar on the right edge to scroll the list.) The currently selected mission is yellow. Information about that mission appears in the *About Mission* box on the right.

LOAD — Load the currently selected mission. A pop-up window will show the progress of the load; click the **CANCEL** button on this pop-up if you want to stop loading and return to the *Single Missions* screen.

BACK — Go back to the previous screen.

Note: *Once you click* **FLY** *at the bottom of the Tactical Display screen, you've begun the mission. If you quit without successfully completing your mission objectives, you will have failed the mission. (You can refly missions as often as you like.)*

Once the mission has loaded, you will begin the mission pre-flight, at the *Tactical Display* screen (see ***Tactical Display* Screen**, p. 1.15).

Campaign Screen

Jane's *USAF* offers four campaigns. Two historical campaigns are taken directly from the conflict in Vietnam and Operation Desert Storm. One futuristic campaign (Sleeping Giant) is a fictional conflict set in Germany. The other futuristic campaign (Red Arrow) consists of dogfighting with MiG fighters, air-to-air operations, and air-to-ground operations in the continental US.

In the historical campaigns you can access all missions at any time. In the future campaigns, you must successfully complete each mission to advance to the next. Campaign missions count toward your currently selected pilot's kill tally, statistics, score, and rank (see ***Pilot Records* Screen**, p. 1.26).

For background reference information on the campaign scenarios, see the **Background: Campaigns**, pp 6.10-6.28.

Starting or Rejoining a Historical Campaign

The text options in the top right corner of the screen control which missions are displayed in the *Missions* box on the left side of the screen. The currently selected option is highlighted in gold.

HISTORY Display the DESERT STORM and VIETNAM tabs.

DESERT STORM Display Desert Storm campaign missions in the *Missions* box.

VIETNAM Display Vietnam campaign missions in the *Missions box.*

Click on a mission in the *Missions* box on the left side of the screen to select it. (The currently selected mission is yellow.) Information about that mission appears in the *About Mission* box on the right. All missions are available at all times, and you can fly missions in any order.

Load the currently selected mission. A pop-up window will show the progress of the load; click the **CANCEL** button on this pop-up if you want to stop loading and return to the *Campaigns* screen.

Go back to the previous screen.

You begin the mission pre-flight, at the *Tactical Display* screen (see p. 1.15.)

Winning Historical Campaigns

To win the campaign, you must successfully complete every mission in that campaign. When you do, you will be awarded the Vietnam Service Medal (for Vietnam campaign) and the Kuwait Liberation Medal (for Desert Storm campaign).

- To pass a mission, you must achieve all of your mission objectives and either quit when prompted, or (if you choose to continue flying) land safely.
- If you quit out before completing your objectives, you will fail the mission. This won't affect your pilot's score, but the mission's status will be "Failed."
- You can re-fly historical campaign missions as often as you like from the Campaign screen. You can win the campaign by passing missions that you've previously failed.
- Once you have passed a mission, its status will remain "Passed." This is true even if you fly it later and fail it.

Starting or Rejoining a Future Campaign

The text options in the top right corner of the screen control what is displayed in the box on the left side of the screen. The currently selected option is highlighted in gold.

FUTURE Display SLEEPING GIANT and RED ARROW tabs.

OPERATION RED ARROW Display information about the current state of the futuristic Grand Canyon campaign.

OPERATION SLEEPING GIANT Display information about the current state of the futuristic Germany campaign.

In both futuristic campaigns, you must closely manage your pilots, aircraft and weapons. At least one time (possibly two times) during each campaign, you'll need to fly weapon and supply missions (see facing page).

Campaign Info Box

The *Campaign Info* box on the left side of the screen displays information about the overall state of the campaign. A text box explains overall goals and summarizes the situation; use the scroll bar to the right to scroll through this text.

About Mission Box

The About Mission box displays information about the mission you are about to undertake, including a brief textual explanation of the situation, a list of the flights assigned to the mission, and a map of the overall mission area.

BACK Go back to the previous screen.

Campaign Control Window

When you start a future campaign, a small window appears onscreen. The *Campaign Control* window has four buttons that let you view information about your remaining aircraft and weapon resources.

RESOURCE Open the *Resource Status* window.

WEAPON SUPPLY MISSION Click to fly a Supply mission. Becomes available when you do not have enough ordnance to complete the campaign. The number remaining is the number of Supply missions you have left.

DEPLOY AIRCRAFT Click to fly a Deploy mission. Becomes available when you do not have enough planes and pilots to complete the campaign. The number remaining is the number of Deploy missions you have left.

QUIT CAMPAIGN Quit the campaign and return to the *Main Menu* screen.

The WEAPON SUPPLY MISSION and DEPLOY AIRCRAFT options are only available if you're running low on aircraft, pilots or weapons and can't finish the campaign without restocking. You can fly up to two missions of each type. If either option is grayed-out, you've either used up all available missions of that type, or you're not running low yet.

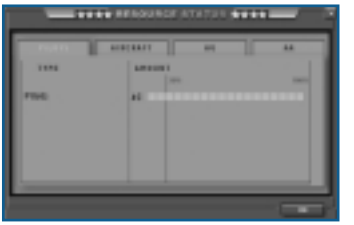
Deploy Aircraft/Weapon Supply Mission

Over the course of the campaign, your resources will dwindle as you expend ordnance, lose aircraft and possibly lose pilots. When your resource levels are too limiting, you may need to fly a Deploy Aircraft or Weapons Supply mission.

You can fly each of these missions only twice. (This is true for both the futuristic Sleeping Giant and Red Arrow campaigns.)

Resource Status Window

This window charts the resources available to you at the current state of the campaign. Click on the tabs at the top of the window to view the current status of the corresponding resource(s): PILOTS, AIRCRAFT, AG (air-to-ground ordnance) and AA (air-to-air ordnance).



For each resource, the following is listed:

Type. Breaks down resources by designation (i.e., AGM-65, MK-82, etc. for AG ordnance)

Amount. Lists the number of this resource type currently available to you. The green bar beside the number illustrates the amount remaining as a percentage of the amount you started with.

Winning a Futuristic Campaign

You will win a futuristic campaign when you have successfully completed all of the missions in that campaign.

- You must successfully complete each mission to advance to next one.
- To pass a mission, you must achieve all of your mission objectives and either quit when prompted, or (if you choose to continue flying) land safely.
- If you quit out of a mission before completing your mission objectives, you will fail the mission. This won't affect your pilot's score, but you will have to refly the mission successfully before you can advance to the next one.
- Once you've passed a mission, it will be available from the *Single Missions* screen. When flown as single missions, they will not count toward the outcome of the campaign.

MISSION SCREENS

Tactical Display Screen

The *Tactical Display* screen is available within every mission — both before the mission, when it displays your mission briefing and the target area, and during the mission, when it displays a real-time aerial view of mission events. All functionality described in this chapter is available both before and during flight unless otherwise indicated.

MENU Click the gray **MENU** button at the bottom of the screen to return to any other screen.

(If you are in flight, you will see a prompt asking if you want to end the mission. Click **NO** if you want to continue your current mission. Click **YES** to end the mission and continue to the interface screen you've selected.)

LOADOUT (Not available during flight.) Click the blue **LOADOUT** button to go to the *Loadout* screen. Use this screen to adjust your weapons load. See **Loadout Screen**, p. 1.22.

VISIT (Not available before flight.) Click this button to jump to a close-up camera view of a selected object. See **Visit**, p. 1.21 for details.

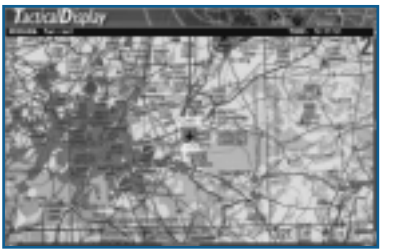
FLY When you are ready to fly (or return to the cockpit view if you are in flight) click the **FLY** button in the bottom right corner of the screen.

BACK Click this button to return to the previous screen (the last one you visited).

Before a Mission

After your Quick, Single, Campaign or special Multiplayer mission has loaded, the *Tactical Display* screen displays your briefing for that mission, including a mission area map and information about waypoints, threats and flight selection.

Map and Map Tools



The largest frame on the *Tactical Display* Window displays a map of the mission area, along with the name of the mission and the mission time. You can scroll the map using the scroll bars on the bottom and right edges of the map. You can also move the map with the Map Tools. By default these tools appear at the right of the map; however, you can click and drag them anywhere on the screen.

Toggle map display. (Map is visible by default.)

Changes your cursor back to normal function (an arrow-shaped cursor)

Click this icon to zoom the map out

Click this icon to zoom the map in

Click this icon to change the cursor to a cross hair with a box attached. Use the cursor to draw a box around an area of the map to zoom in to that area.

Click this icon to change the cursor to a hand. Use the hand cursor to click and drag the map, moving it around.

Click this icon to change the cursor to a cross hair. Click on the map with the cross hair to center the map where you've clicked.

Briefing Window

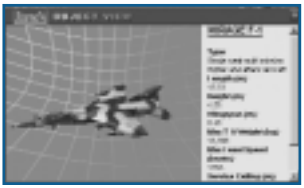
The briefing lists the mission name and type, with a brief description of the situation, weather, available intelligence, flight tasking, objectives, safety concerns and helpful tips. You will want to pay particular attention to the Intelligence, Flight Tasking and Mission Objectives sections.

Click the **BRIEFING** button in the top left corner of the Tactical Display Screen to open a gray *Briefing* window on top of the map.

- Click the **PRINT** button at the bottom of the window to print your briefing.
- Click the **X** button at the top of the window to close the window.

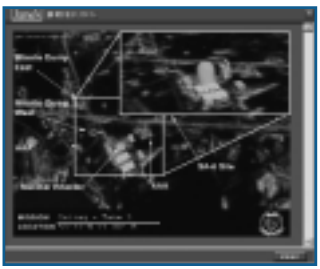
Intelligence Section

This section of your briefing lists your targets and all *known* threats in the area. (The threats listed may not be the only threats!). Light-blue, underlined text indicates a hotlink to additional reference windows.



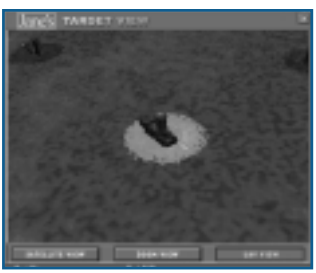
***Object View* windows.** Pop-up *Object View* windows display a 3D model of the threat or target and list specifications from Jane's Information Group, Ltd.

- Use the arrow keys on the keyboard to rotate the model.
- Use the scroll bar at the left edge of the window to scroll through the Jane's text.
- Click the **x** button at the top of the window to close it.



***Target Photo* windows.** For some targets, a link to pop-up *Target Photo* window may be provided. These photos give an overall view of the target area with exact location coordinates. An enlarged view of the target area may also be provided, with structures called out to help you recognize you specific target elements once you reach the area.

- Click-and-drag this window to resize or move it.



***Target View* windows.** These windows display live footage of the target area (and therefore cannot be printed out). Use the buttons at the bottom of the window to change views.

SATELLITE VIEW Switch to an overhead view of the target area from an intelligence satellite.

ZOOM VIEW Switch to a zoomed-in version of the above view. Rotate the view using ← and →.

UAV VIEW Switch to a rotating, 3D view of the target from the camera on an Unmanned Aerial Vehicle (UAV) flying over the target area. UAVs are small, remotely controlled airplanes used for surveillance, target tracking and bomb damage assessment.

- Click the **x** button at the top of the window to close it.

Tasking Section

List each flight in the mission, along with the number and type of aircraft in each flight, and each flight's task and targets. As in the intelligence section, light-blue, underlined text marks hotlinks to additional reference windows. A brief overview of tasks is listed below.

CAP. (Combat Air Patrol) Fly around a specified waypoint or along a specified path in search of aircraft threats. Often performed in support of another mission element that is executing a ground strike.

CAS. (Combat Air Support) Fly to the specified target area and strike tanks, ground artillery, troops and other enemy ground force elements. This task is always performed in support of friendly ground force elements operating within or near the target area.

Escort. Defend a specified friendly unit(s) from enemy attack as it travels through its waypoints. Escort missions are generally performed in support of friendly air elements that are executing the main mission objective. The objective of the mission is to keep the escorted aircraft out of harm's way.

Intercept. Neutralize an attack by enemy aircraft, such as fighters that are attempting to interfere with a mission, or bombers that have targeted a friendly ground installation.

SEAD. (Suppression of Enemy Air Defenses) Destroy enemy AAA and SAM sites, and perhaps ground control radar installations to clear a path for another strike force. Target types include surface-to-air missile sites, anti-aircraft artillery batteries and any associated radar systems.

Strike. Fly to the specified target area and strike specified targets. Targets might include anti-air sites, storage or production facilities, radar installations, and other strategic structures. Sometimes strike operations are performed in support of another air element — for example, to destroy enemy AAA and SAM sites to clear a path for another strike force. Sometimes they are the mission's main strategic objective.

Note: *In* Jane's USAF*, you are responsible for completing every flight's task (see* **Flight/Aircraft Buttons***, p. 1.20). Make sure you note which flight is responsible for which task — the aircraft assigned to it and their weapons loadout will probably be best suited to the task it has been given. For example, if two F-15Cs are assigned to fly a CAP for A-10s on a ground strike, the slow low-flying A-10s would have extreme difficulty taking over the air-to-air role and the F-15Cs probably wouldn't have the loadout for the ground work.*

Mission Objectives

Pay very close attention to the information listed in this section. Here you will be told exactly what you are responsible for in the mission.

Map Navigator Window

This window displays an overview map of the mission area. The portion of the map currently displayed in the main window of the *Tactical Display* screen is marked by a red box. You can click and drag this red box inside the *Map Navigator* window to control which portion of the map is displayed in the larger window. Click the **X** button at the top of the window to close it. (You can also press the **MAP NAVIGATOR** button to close it.)

Click the map navigator button (second button on the left) in the *Tactical Display* screen to open and close the *Map Navigator* window.

Map Icon Buttons

The rest of the buttons to the left of the map control what mission elements are displayed on the map. Each button (except **WAYPOINTS** and **INTELLIGENCE**) consists of red and blue icon buttons (that can be lit or dark) and a gray text button (that can be raised or depressed).

(red) Click the red icon buttons to display/hide only enemy objects of this type.

(blue) Click the blue icon buttons to display/hide only friendly objects of this type.

When the icon buttons are lit, the objects are displayed; when they are dark, the objects are hidden.

Click the text buttons listed below to hide/display all objects of that type. When a button is depressed, the corresponding objects are displayed. When a button is raised, the objects are hidden.

Display/hide aircraft, including fighters, support aircraft, and helicopters.

Display/hide vehicles, including tanks, trucks, and armored vehicles.

Display/hide SAM sites.

Display/hide AAA sites.

Display/hide runways

Display/hide structures and radar.

Display/hide SAM kill radii. These circles indicate the effective range of each SAM site.

Display/hide your waypoints.

Superimpose a window with troop locations and arrows indicating troop movement over the map.

Flight/Aircraft Buttons

The flight and aircraft buttons at the bottom of the screen allow you to center the map on different friendly flights or aircraft. In missions flown by more than one flight, you can also use these buttons to jump from flight to flight.

Click on a flight text button (**AUSTIN**, **BUICK**, **CORVETTE**, etc.) to take control of that flight. The map will re-center on the flight's current location, and the flight button turns yellow.

Click on the numbered aircraft icon buttons to re-center the map on that aircraft. (This does not affect which flight you are in.) The button for your aircraft is green, all other aircraft buttons are blue.

Human pilots will always lead a flight of computer wingmen. Aircraft 1 is always the flight leader.

Note: *You cannot change flights in basic or weapons training missions.*

Record Mission Button

Use the Record Mission feature if you'd like to record the mission you are about to fly and view it later in the *Mission Recorder* screen (see **Mission Recorder Screen,** p. 1.33). When the red, circular button is depressed and the red light is illuminated, you are recording. You can stop recording at any time by clicking the button again. You can't turn mission recording on/off once the mission has begun, however. Only in-flight actions will be recorded — your *Tactical Display* screen actions, for instance, won't show up on the final tape.

Toggle the mission recorder on/off

In-Flight

You can also access the *Tactical Display* screen while flying by pressing Esc.

- The game keeps running while you are viewing the *Tactical Display* screen.
- The *Loadout* screen is unavailable in-flight.
- To switch to another flight, click the center button of that flight, then click **FLY**.
- If you want to end the mission while in flight, press Ctrl Q. You can also go to the *Tactical Display* screen, the click the **MENU** button at the bottom of the screen and choose any option.

Note: *If you end a mission before you have successfully completed your mission objectives you will fail that mission.*

Real-Time Map Display

While in-flight, the map window displays the movement of all mission elements in real time. The map tools and map icon buttons function exactly as they do when you are on the ground, allowing you to move and zoom the map and hide or display different mission elements (see **Map and Map Tools**, p. 1.16 and **Map Icon Buttons**, p. 1.19).

Visit

Use the VISIT button to view any mission element — including ground forces, target structures and both enemy and friendly planes. Alternatively, double-click on any icon.

To visit an object:

- Click on an icon to select the object you want to look at.

 Click the VISIT button at the bottom of the screen.

 Move the mouse to rotate the view around the object.

[-] / [+] Zoom view in and out.

[Esc] Return to *Tactical Display* screen.

Switching Aircraft/Flights

During a mission, you can use the flight and aircraft buttons at the bottom of the *Tactical Display* screen to jump into different aircraft or flights. *You must finish the objectives for all flights, not just the one you fly initially.* For this reason, you may want to spend time fine-tuning loadouts for each flight before you take off — that way, you'll be prepared for whatever the mission holds in store.

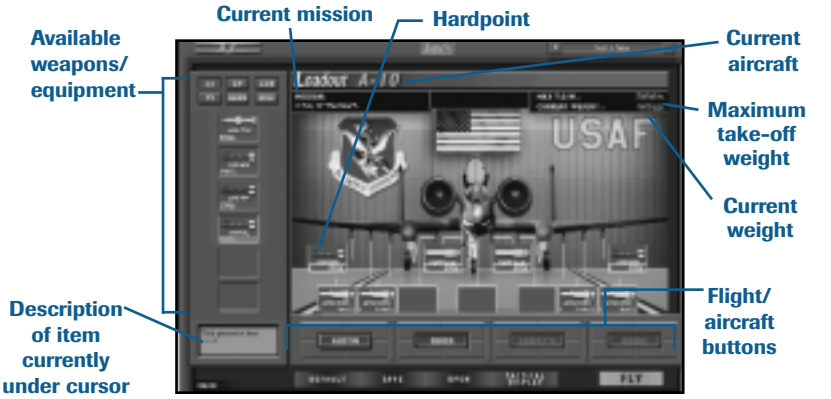
 Press a flight button to jump to a different flight, if one is available. You must always fly the lead aircraft (aircraft 1) unless it is destroyed during a mission. Then you will fly lead in the next available aircraft (aircraft 2, then 3, then 4).

 Press an aircraft button to center the map around that aircraft.

- If your aircraft is destroyed during a mission and you are flying with at least one other friendly, you will automatically jump to the *Tactical Display* screen, where you can choose a new aircraft.
- You must complete the mission objectives for all flights to win a mission. As soon as you successfully complete one flight's objectives, you can continue in either your aircraft or select another flight and take over its mission. The mission won't end until all flights' mission objectives have been completed or all mission aircraft have been destroyed.
- Press [Shift] [1], [2], [3], or [4] to switch to Flights 1, 2, 3 or 4 without using the *Tactical Display* screen. The mission won't end until all flights' mission objectives have been completed or all mission aircraft have been destroyed.
- To manually end a mission, press [Ctrl] [Q]. Or, click the MENU button at the bottom of the *Tactical Display* screen and choose any option. You will fail the mission if you end it before completing your objectives.

Loadout Screen

Click the **LOADOUT** button at the bottom of the *Tactical Display* screen to go to the *Loadout* screen and customize weapons load for all flights in your mission.



DEFAULT Return to the default loadout for the currently selected flight (see **Flight/Aircraft Buttons**, p. 1.20).

SAVE Save the current loadout to your hard drive in order to use it later. You may want to set up a custom loadout for use against a specific target type, or a loadout that best utilizes your weapon delivery skills. Another advantage to saving custom loadouts is that it considerably speeds up the process of setting up a multiplayer game.

Loadout files (*.ldt) are specific to the type of aircraft for which they were created (F-22, F-15, etc.). By default, loadouts are saved under **Program Files\Jane's Combat Simulations\USAF\Resource\Loadouts\<name of aircraft>**. (This path will be different if you did not install the game to the default location.)

OPEN Open a saved loadout. Loadouts are specific to a type of aircraft — the game will automatically point you to the folder in which loadouts for your currently selected aircraft type are stored by default.

TACTICAL DISPLAY Return to the *Tactical Display* screen. If you have made any changes to a loadout, you will be prompted, "Use Loadout?" Click **YES** to keep the changes or **NO** to lose the changes.

FLY Enter flight. If you have made any changes to a loadout, you will be prompted, "Use Loadout?" Click **YES** to keep the changes or **NO** to return to the *Tactical Display* screen.

BACK Click this button to return to the *Tactical Display* screen.

Customizing a Loadout

Choosing a Flight

All aircraft in a flight carry the same weapons and equipment: when you reconfigure this plane's loadout, you are reconfiguring the loadout for all aircraft in the currently selected flight.

Select the flight for which you want to view a loadout. The currently selected flight's button is yellow.

Viewing Available Weapons/Equipment

The box on the left side of the screen displays all weapons available to the currently selected aircraft. Weapons availability is limited by the type of aircraft you are flying (not all weapons can be loaded on all aircraft) and in some missions — particularly campaign missions — the number and types of stores available at the current stage of battle.

Six buttons across the top of this box control which type of stores are displayed in the box:

AA Display available air-to-air weapons (e.g., AIM-120)

GP Display available unguided, general purpose bombs (e.g., Mk-82)

LGB Display available laser-guided bombs (e.g., GBU-10)

TV Display available TV-guided bombs (e.g., AGM-65)

HARM Display available HARM weapons (e.g., AGM-88)

MISC Display available guidance and ECM pods and fuel tanks (e.g., ALQ-119)

When you place your cursor over a displayed weapon or equipment pod, a brief description of that item appears in the text box at the lower left corner of the screen.

For more information on the different weapons, see **Combat: Using Weapons**, p. 4.28. For more information on different targeting systems, see **Combat: Targeting**, p. 4.23.

Loading and Unloading Equipment

The box on the right side of the screen contains a picture of the currently selected flight's aircraft with all hardpoints called out. The aircraft designation (e.g., F-15C, F-22) is listed at the top of the box.

Weapons that appear inside the hardpoint boxes are currently loaded on the aircraft. The number of weapons loaded onto that hardpoint and their total weight are listed beneath the weapon. Blank hardpoint boxes denote empty hardpoints.

Tactical Considerations

Many tactical considerations affect your loadout. You will need to review your briefing, determine which kinds of targets and/or threats you are likely to face, and load effective weapons. For ground strike missions, the level of precision required for the strike should also influence your weapon choice. Weather conditions may also affect your choice of weapons — IR-seeking missiles are more effective at night, but TV-guided weapons may be useless. You may also need to load additional targeting and sensor pods to use certain types of weapons.

See **Combat: Using Weapons,** p. 4.28, for more information on weapons.

Load and Unload Equipment

- To load, click an item in the available weapons/equipment box and drag it to a hardpoint. This loads the maximum number you can carry on the hardpoint.
- You can load an item onto a hardpoint that is already loaded — the new item will replace the old one.
- To unload, right-click on a hardpoint (or click on the item on the hardpoint and drag it off). Each right-click unloads a single weapon.
- If you have a weapon loaded onto a hardpoint, you can left-click on the hardpoint to add another weapon of the same kind, up to the maximum number that the hardpoint will hold.
- Hardpoints are generally designed to carry certain types of weapons or equipment. You won't be able to successfully mount an item to a hardpoint that cannot carry it. Try dragging the item to a different hardpoint. Usable hardpoints have yellow outlines that appear when you select a certain weapon, while unusable hardpoints have white outlines.

Weight and Balance

When you are customizing a loadout, pay attention to weight and balance.

- The current aircraft's **Max T.O.W.** (maximum takeoff weight) and **Current Weight** are listed above the aircraft. The current weight must be less than the max T.O.W. weight, or the flight will never make it off the runway.
- If your load is not evenly balanced on both wings (i.e., heavier on one wing than the other), a red warning light appears at the top center of the screen. Equalize the weight by adding or removing weight from the opposite wing.

Debrief Screen

Once you have completed a mission (successfully or unsuccessfully) you will see the *Debrief* screen. The *Debrief* screen gives a summary and statistics for your performance during the mission. Click the text buttons on the left side of the screen to display the corresponding information on the right.

SUMMARY. Sums up the results of the mission.

MISSION LOG. Gives a chronological log of mission events. Events listed in **green** contributed positively (or neutrally) to the mission; events listed in **red** contributed negatively.

KILL TALLY. Lists all enemy aircraft, ground forces and structures killed by the task force, along with a tally of your personal kills. The total points for the task force kills are tallied on the right.

USAF LOSSES. For aircraft, lists total losses and number of friendly kills (i.e., aircraft killed by friendly fire). For ground forces and structures, lists those killed by friendly fire, and total losses. Points deducted for friendly losses are tallied on the right.

MISSION STATISTICS. Summarizes *your* performance in each plane that you flew — your total flight hours, number of kills and kill/loss ratio in those planes — and then list your totals in these categories. Click on the buttons beneath the table to view:

> **PERFORMANCE PER PLANE CHART.** Graphs the kill/loss ratio for each aircraft in this mission. Each bar represents a single aircraft. The height of the bar reflects the kill/loss ratio, which is equal to the total number of kills divided by the number of times that aircraft was destroyed.
>
> **LOSS ANALYSIS CHART.** Displays a pie chart that shows the cause of your loss during the mission — a crash, enemy air-to-air missile, SAM, etc.

Once you have finished viewing your stats, click **REPLAY MISSION** to fly the mission over or **CONTINUE** to return to the screen where you selected/created the mission (*Single*, *Quick Mission*, etc.).

If you recorded the mission, a **RECORDED MISSION** button also appears. Click this to go to the *Mission Recorder* screen and review your mission.

TOOLS SCREENS

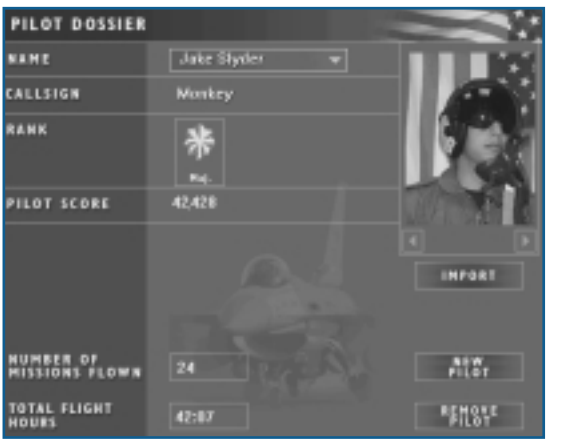
Pilot Records Screen

From the *Pilot Records* screen, you can view the stats of your current pilot, load a saved pilot and create and delete pilots. Click the text buttons in the box to the left of the screen to call up the corresponding window. (The currently selected button is yellow.)

BACK Go back to the previous screen.

Pilot Dossier

The *Pilot Dossier* window displays basic statistics for your currently selected pilot. You can also use this area to change your current pilot, create new pilots and delete those you no longer need from this window.



Changing Your Current Pilot

To select a pilot, choose the pilot's name from the drop-down menu. The currently selected pilot will be available to fly when you leave the *Pilot Records* screen. (He won't appear in the drop-down pilot window until you leave this screen — see **Drop-Down Pilot Window**, p. 1.2.)

Creating a New Pilot

NEW PILOT Create a new pilot. Type the pilot's name and callsign in the pop-up window that appears and click **OK**.

Deleting a Pilot

REMOVE PILOT Delete currently selected pilot.

Current Pilot Information

The following statistics are displayed in the *Pilot Dossier* window.

Callsign/Name. Display current pilot's name and callsign.

Photo. Displays a picture of your current pilot. A default photo is provided for you.

IMPORT If you would like to replace the default photo with another image, click the **IMPORT** button, then locate the image on your hard drive and click **OPEN**. The image must be in bitmap (.bmp) format.

Rank. Shows your pilot's current rank insignia. The current rank reflects all Single, Campaign and Training missions that this pilot has flown. See **Rank**, p. 1.31.

Pilot score, Number of missions flown and **Total flight hours.** The totals for your current pilot, tallied from all pre-scripted missions the pilot has flown (i.e., Single, Training and Campaign missions).

Your current pilot's performance in Quick Mission and Fly Now missions does not affect these statistics. The only exception occurs when you host a multiplayer game using this pilot in a cooperative mission (but not in any other type of multiplayer game).

Mission Status

The *Mission Status* window charts the currently selected pilot's success and failure in pre-scripted missions on a mission-by-mission basis. Mission series are listed on the left; mission numbers are listed across the top. Mission 1 is the first mission in a series, mission 2 the second, and so forth.

The series are as follows:

- BASIC TRAINING, WEAPON SCHOOL and RED FLAG = training mission series
- VIETNAM WAR, DESERT STORM, RED ARROW and SLEEPING GIANT = campaign mission series
- SINGLE = single missions that aren't also part of a campaign.

A red FAILED status indicates you quit the mission or lost all friendly force aircraft before successfully completing all of your mission objectives. A green PASSED status indicates you successfully completed all of your mission objectives.

Kill Tally

The *Kill Tally* window lists the enemy aircraft, ground forces and structures you have destroyed, broken down by object type. The kills listed are for all pre-scripted missions the current pilot has flown (i.e., Single, Training and Campaign missions).

Your current pilot's performance in Quick Mission and Fly Now missions does not affect these statistics. The only exception occurs when you host a multiplayer game using this pilot in a cooperative mission (but not in any other type of multiplayer game).

(red)	Represents objects destroyed by friendly forces. The designation and number of objects are listed beneath the icon.
TOTAL TASK FORCE	Lists the number of aircraft, ground forces or structures destroyed by friendly sides.
PERSONAL	Lists the number of aircraft, ground forces or structures destroyed by your current pilot.

USAF Losses

The *USAF Losses* window is similar in format to the *Kill Tally* window. It lists the friendly aircraft, ground forces and structures destroyed during all pre-scripted missions flown by your current pilot (i.e., Single, Training and Campaign missions).

Your current pilot's performance in Quick Mission and Fly Now missions does not affect these statistics. The only exception occurs when you host a multiplayer game using this pilot in a cooperative mission (but not in any other type of multiplayer game).

(blue)	Represents objects destroyed by friendly forces. The designation and number of objects are listed beneath the icon.
FRIENDLY KILLS	Lists the number of friendly aircraft, ground forces or structures destroyed by other friendly forces.
TOTAL LOSSES	Lists the total number of friendly aircraft, ground forces or structures.

Pilot Statistics

The *Pilot Statistics* window tracks your pilot's performance in different types of aircraft and over time.

Charts your current pilot's performance in each type of aircraft, including his FLIGHT HOURS, the KILLS ACHIEVED and KILL/LOSS RATIO in that aircraft. Totals in the these three categories are then listed below this chart.

Click the buttons below the chart to view the following graphs:

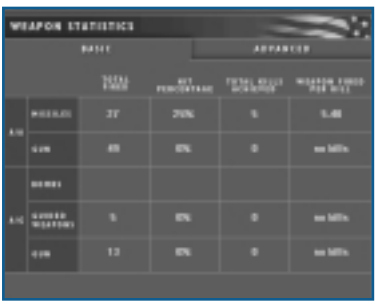
PERFORMANCE PER PLANE CHART. Displays a chart listing the kill/loss ratio for each aircraft during the pilot's overall career. Each bar represents a single aircraft. The height of the bar reflects the kill/loss ratio, which is equal to the total number of kills divided by the number of times you were destroyed.

LOSS ANALYSIS CHART. Displays a pie chart that shows the cause of your loss during the mission — a crash, enemy air-to-air missile, SAM, etc.

SKILL LEVEL CHART. View a graph of how your kill level has increased/decreased as you have gained additional flight hours with this pilot. (A steady climb would indicate that as your experience increases, so does your lethalness.)

Weapon Statistics

The *Weapons Statistics* window records the number and types of weapons you've fired, hit percentages, kills achieved and weapons fired per kills.



Click on the **BASIC** tab to see a breakdown by *class* of weapon (air-to-air missiles, air-to-air guns, etc.). Click on the **ADVANCED** tab to see a breakdown by weapon designation (AIM-7F, MK-82, etc.).

The following stats are listed for each category:

TOTAL FIRED	The total number of this type of weapon that your current pilot has released.
HIT PERCENTAGE	The percentage of released weapons of this type that hit their targets (both guided and unguided).
TOTAL KILLS ACHIEVED	Number of targets destroyed by weapons of this category.
WEAPON FIRED PER KILL	Average number of weapons in this category fired to make a kill.

Mission Statistics

The *Mission Statistics* window shows performance statistics broken down by mission category. Click on the text buttons to select a category (the currently selected button is yellow).

ALL	View stats for all pre-scripted missions (Training, Single and Campaign).
BASIC TRAINING	View stats for the basic training series of Training missions (see ***Training* Screen**, p. 1.8).
WEAPON SCHOOL	View stats for the weapon school series of Training missions (see **Training Screen**, p. 1.8).
RED FLAG	View stats for the Red Flag series of Training missions (see **Training Screen**, p. 1.8).
DESERT STORM	View stats for the Desert Storm campaign series (see ***Campaigns* Screen**, p. 1.10).
VIETNAM WAR	View stats for the Vietnam War campaign series (see **Campaigns Screen**, p. 1.10).
SLEEPING GIANT	View stats for the Sleeping Giant (Germany) campaign series (see ***Campaigns* Screen**, p. 1.10).
RED ARROW	View stats for the Red Arrow (Grand Canyon) campaign series (see ***Campaigns* Screen**, p. 1.10).
SINGLE	View stats for the series of Single missions that are not also part of a campaign (see **Single Missions Screen**, p. 1.9).

In each category, the following statistics are given:

TOTAL SORTIES FLOWN	Number of missions in this category that your current pilot has flown
MISSION SUCCESS PERCENTAGE	Percentage of these missions that were successful
AVERAGE MISSION SUCCESS TIME	Average time current pilot requires to successfully complete a mission
MINIMUM MISSION SUCCESS TIME	Fastest time in which pilot has successfully completed a mission
AVERAGE AA KILLS PER MISSION	Average number of air-to-air kills pilot makes in a mission.
MAXIMUM AA KILLS PER MISSION	Highest number of air-to-air kills pilot made in a mission
AVERAGE AG KILLS PER MISSION	Average number of ground objects pilot destroys in a mission
MAXIMUM AG KILLS PER MISSION	Highest number of ground objects kills pilot destroyed in a mission

Rank

The *Rank* window provides a record of your pilot's promotional history, listing the RANKS and insignia he has earned, and the point in his career when he earned each rank (FLIGHT HOURS AT PROMOTION and MISSION).

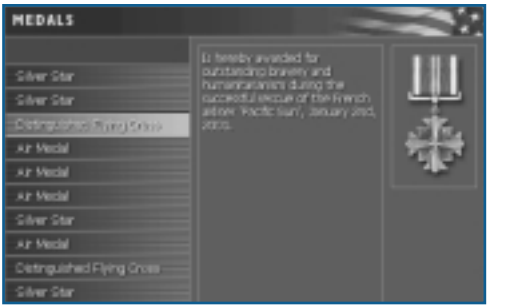
When you complete a mission, you receive a mission score. Once your pilot accumulates enough points, that pilot will receive a promotion. You'll find out about any promotions in the **Debrief Screen**, p. 1.25. To view a pilot's current rank, look at his **Pilot Record**, p. 1.26. Rank also appears in the upper right corner of all pre-flight screens.

Ranks (in order received)	Points
2nd Lieutenant	0
1st Lieutenant	5000
Captain	15,000
Major	25,000
Lt. Colonel	45,000
Colonel	70,000
Brigadier General	100,000
Major General	130,000
Lt. General	160,000
General	200,000

Note: *If you score enough points during a mission for a promotion, but you fail the mission, you won't be promoted. You'll get to keep your points, and the promotion will be awarded the next time you pass a mission.*

Medals

See the *Install Guide* for more details on scoring and medals.



When you complete certain parts of the game and/or surpass a certain score, your pilot will receive a medal. You can view your pilot's current medals (as well as all potential medals) in the **Pilot Records Screen**, p. 1.26. Click on the name of a medal to display it.

The medals in the game are modeled after actual US Air Force decorations. For the sake of preserving some element of suspense and surprise, specific mission and score requirements are not listed here. You can receive specific medals for accumulating a certain score, and campaign medals for completing each individual game campaign.

Mission Medals/Patches	
Red Flag Participant Patch	*Air Force Achievement Medal*
Medal of Honor	*USAF Vietnam Service Medal*
Air Force Cross	*USAF Emirate of Kuwait Liberation Medal*
Silver Star	*Red Arrow Medal*
Distinguished Flying Cross	*Sleeping Giant Medal*
Air Medal	

- As with promotions, you won't receive a medal in any mission that you fail.
- You can only earn one medal of one type for a particular mission — even if you replay that same mission and score enough points for a second medal, you won't receive one for that mission again.
- You can receive multiple medals of the same type.
- You can't receive any medals while flying on the red side.
- You don't receive any medals for any of the training missions.
- It is possible to be awarded both a mission medal and a campaign medal when completing a mission.
- You can collect multiple medals for completing the same future campaign more than once. (This is only true for future campaigns.)

Mission Recorder Screen

Before beginning a mission, you have the option of recording it by clicking the **Record Mission** button on the *Tactical Display* screen. (See **Tactical Display Screen, p. 1.15**) You can load, view and save these recorded missions with the *Mission Recorder* screen. Missions can be played back in the *Recorder* screen, as well as in full-screen mode. Finally, you can send these missions to other players for viewing.

Recorder Control Panel

Use the *Recorder Control Panel* to open, save, rewind, play, pause and re-record recorded missions.

Open a recorded mission. By default, recorded missions (*.rec files) are saved in **Program Files > Jane's Combat Simulations > USAF > Resource > Recorder**. Select a mission, then click **OPEN**. The last mission you recorded is called LastMission.rec.

Save a recorded mission.

Rewind the mission.

Increase/decrease the rewind speed by clicking on the up and down arrows in the window.

Pause the playback.

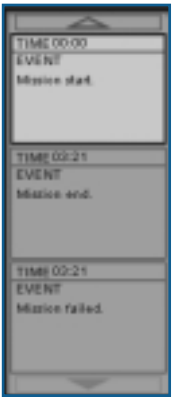
Playback the mission at regular (1x) speed.

Increase/decrease the playback speed by clicking on the up and down arrows in the window.

Record camera views during the movie. This allows you to switch views while watching the playback tape and save them into the recorded mission file.

See a full-screen view of the mission (i.e., without menus, panels, etc.). Press Esc to get back to the regular view.

Playback and Tactical Display Tabs



You can view either a "film" of the mission or you can watch the movement of mission elements on the *Tactical Display* screen. Click on the **PLAYBACK** and **TACTICAL DISPLAY** tabs on the panel to the left of the main viewing area to switch back and forth.

A list of events appears in the screen-like area beneath the tabs. These events are automatically marked while the mission recorder is active. You can click on any of these events to make the recorded mission jump to that point in the film. Click the up and down arrows to scroll through the list of events.

Visiting

You can visit any mission object during playback.

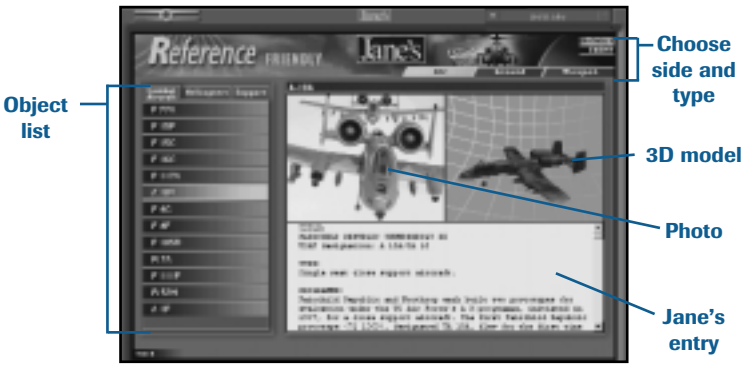
- To visit USAF aircraft, click on the flight or aircraft button below the viewscreen. You can watch exactly what you did during the mission, or what other objects did. You can access the Tactical Display, watch other flights, watch the scene from the enemy's point of view, or visit a ground target.
- To visit other mission elements, click on the **TACTICAL DISPLAY** tab, then click on the object's icon. Then click the **VISIT** button.

VISIT	Jump to a camera view of the selected object. Move the mouse to rotate the view. Press [+]/[−] to zoom the view. You can visit any object in the game.
VISIT PLAYER COCKPIT	Press at any time to see the action from the point of view of your cockpit. (Since this is a recording, you will not be able to access any of the controls. You can only watch.)
VISIT COCKPIT	Press to view the action from the point of view of the currently selected friendly aircraft's cockpit (not available when any other object is selected). If you choose any other type of object, you'll see an outside view. You can change the camera angle, but nothing else.

Press [Esc] to get back to the mission recorder screen.

Reference Screen

The *Reference* section contains more detailed information about most of the objects in the game and their real-world counterparts. This mini-encyclopedia is taken directly from the Jane's reference books.



Object List

The text options in the upper left control which objects are displayed in the object list on the right.

SIDE

- **FRIENDLY** List USAF and other US military equipment.
- **ENEMY** List equipment used by opposing forces in the game.

TYPE

- **AIR** List fighters, bombers, helicopters and support aircraft.
- **GROUND** List anti-air systems and vehicles.
- **WEAPONS** List air-to-air and air-to-ground weapons and other stores information.

Tabs on the object list break the categories down further. Click on a tab to view that subcategory. Click on an object name to view information about that object. The currently selected item is yellow.

Viewing Box

Information about an object is displayed in the box on the right.

Photo. Click on the photo to enlarge it. Click **OK** to close the enlarged view.

3D Model. Click on the model window to enlarge it. Click **OK** to close the enlarged view. Rotate the model with the arrow keys. Zoom in and out with [+] / [-].

Jane's Entry. Scroll the text to view the Jane's entry for this object.

BACK Go back to the previous screen.

Web Screen

Get the latest on this and other Jane's Combat Simulations games, and connect to related sites. You must have access to the Internet (i.e., a modem or LAN connection, an ISP provider, web browser, etc.) to use this feature. Click on the buttons and links to launch your web browser and jump to a site. (*Jane's USAF* will continue to run in the background.)

Note: *Clicking* **WEB** *from the* Main Menu *screen or the* Web *screen launches your default browser.*

Jane's Combat Simulations' *World War* site

USAF section of the Jane's Combat.Net site

Links to web sites about this game

Comparisons of your statistics and the statistics of other *Jane's USAF* players.

2

COCKPIT

Previous page: Closeup on an F-16C. USAF photo by Senior Airman Jeffrey Allen

Chapter 2

COCKPIT

In *Jane's USAF*, you have the ability to pilot nine different aircraft. Most of the cockpits have similar cockpit elements and avionic systems, all of which are discussed in this chapter.

If you're going to effectively utilize all of your aircraft's avionic functions, it's worth taking some time to read this chapter. There's a lot of information here to absorb, but the objective is to provide you with an in-depth reference to each screen and mode you can access.

Here are the major sections in this chapter, along with their page references. Once you've mastered the cockpit, you'll probably want to read **Chapter 4: Combat** (p. 4.1) to learn how to use weapons.

Aircraft Cockpits (p. 2.4). Learn what aircraft you can fly and take a look at their cockpit layouts.

Physical Gauges and Lights (p. 2.10). Find out what dials, switches, buttons, gauges and lights appear in each flyable aircraft. Most aircraft use the same instruments, although the position varies by plane.

Head-Up Display (p. 2.12). Become familiar with the HUD, the bright display in the middle of your front viewscreen. You'll learn about its modes and functions when different weapons are active.

Multi-Function Display Pages (p. 2.29). Extend your knowledge of MFDs, small square windows in the cockpit dash. Each displays different "pages" of information.

TERMINOLOGY OVERVIEW

What are Modes?

The term *mode* is used in this manual several times, and has different meanings. Simply put, a mode is simply a group of avionics displays and functions suited for a particular task. Several of your aircraft's avionic systems use modes — the HUD, MFDs and onboard weapons and radar systems.

Master Modes. There are three master modes. These modes simultaneously configure your HUD mode, multi-functional display panels, radar mode and weapon systems for one of three basic tasks: navigation (NAV master mode), air-to-air combat (AA master mode)or air-to-ground weapons delivery (AG master mode).

The name of the current mode appears in the lower left corner of the HUD.

[M] Toggle avionics master mode (Navigation / Air-to-air / Air-to-ground)

[N] Toggle NAV HUD

MFD Pages (p. 2.29). Multi-function displays (MFDs) have display modes, but they're usually referred to as "pages." You have access to ten different MFD pages. Some activate automatically when you select certain weapons, while others require manual activation. You can click **MENU** from any MFD to see a list of MFDs. Some MFDs have shortcut keys (listed on p. 2.29).

Radar Modes (p. 2.31). Your onboard radar has both air-to-air and air-to-ground functionality, each with a number of submodes.

[R] Toggle air-to-air / air-to-ground radar

[Q] Cycle through radar submodes

Weapons. The term "mode" loosely applies to weapon systems as well — you can fire air-to-air (A/A) weapons only while in air-to-air master mode, and air-to-ground (A/G) weapons in air-to-ground HUD mode.

[ ] / [ ] Cycle through air-to-air / air-to-ground weapons

What is the HUD?

The Head-Up Display, or HUD, consists of computerized flight, targeting and weapons information that is projected onto a sheet of specially coated glass at the front of the cockpit.

You switch avionics master modes by pressing [M]. (This also changes your MFD, radar and weapon settings.) When you're in a particular master mode, the information displayed on the HUD changes.

Below is a list of master modes and HUD submodes, along with a page reference to help locate details about each one. For in-depth information about the HUD, see **Head-Up Display (HUD)**, p. 2.12.

NAV, p. 2.16 (Navigation)

Landing, p. 2.16

Refuel, p. 2.17

AG, p. 2.25 (Air-to-Ground)

CCIP, p. 2.26 (Continuously Calculated Impact Point)

HARM, p. 2.27

TV, p. 2.28 (TV-guided weapons)

AA, p. 2.18 (Air-to-Air)

LCOS, p. 2.18 (Lead-Computing Optical Sight)

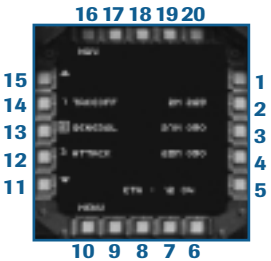
EEGS, p. 2.20 (Enhanced Envelope Gun Sight)

MRM, p. 2.22 (Medium-Range Missile)

SRM, p. 2.24 (Short-Range Missile)

What are MFDs?

Multi-functional displays appear on the front dash of the cockpit. They are small square display panels capable of showing various types of information. Data from many different avionic systems are fed to the MFD.



Around the perimeter of each MFD, you'll find *pushbuttons* that activate different functions or modes, depending on which screen is active. A text label beside each button identifies its function. (For the purposes of this manual, the pushbuttons are numbered and referred to as PB1, PB2, etc.)

To access an MFD page, left-click the MENU pushbutton in any MFD, then choose the pushbutton for the page you want to view. Some MFDs also have keyboard shortcuts; some only activate when certain weapons are active.

PB 10 (MENU) Display MFD menu (on this menu, click a pushbutton to open the MFD listed next to it.)

Here is a list of MFDs and their keyboard shortcuts (if applicable), along with a page reference to help you locate details about each one:

Nav (N, Navigation), p. 2.30

ADI , p. 2.31
(Altitude Direction Indicator)

Radar (R), p. 2.31

RWR (U), p. 2.38
(Radar Warning Receiver)

Tactical (T), p. 2.39

JTIDS (T, in some aircraft), p. 2.40

Stores, p. 2.41
(Stores Management System)

FLIR (I), p. 2.42

TV, p. 2.44

HARM, p. 2.46

Damage (D), p. 2.47

AIRCRAFT COCKPITS

The flyable aircraft share similar cockpit instrumentation, although the position of the dials, switches, gauges and panels may differ. For instance, some cockpits have only two MFD panels, while others have three.

The next section provides diagrams so you'll know what's what, and where it's located in the cockpit. The lettered callouts correspond to the definitions on pp. 2.10-2.11. For Jane's specifications on each of the flyable aircraft, see **Aircraft Specifications** (p 7.1) or the game's *Reference* screen.

View help on the instrument under the mouse cursor.

You can get instant help on any instrument in the cockpit by right-clicking on it while in the normal, 2D cockpit view. (This feature does not work in the 3D, pannable cockpit view.)

Training Missions

If you're learning how to fly but could use a few avionics lessons, the game has a detailed set of training missions to get you familiar with the cockpit and its functions. You can access the training missions by selecting the *Training* screen from the *Main Menu*.

The training missions are separated into three categories. Try the Basic Course missions first to get a feel for flight. Here's a basic recap of the missions — see **Interface: Training Missions**, p. 1.8, for details on specific missions.

Basic Training (4 total). Takeoffs, landings, low-level flight and navigation, and air-to-air refueling.

Weapons School (8 total). A/A and A/G weapons and radar modes, weapon camera views, HUD modes, bombing techniques, dogfighting, radar-warning receiver, SAM avoidance, guided weapons, LANTIRN, stealth flight, night flight, wingman communication, formations, JTIDS.

Red Flag (4 total). Combat-situation missions.

Musical Cockpits

A unique aspect of *Jane's USAF* is the fact that you can fly several aircraft within a single mission. Once you've met the mission objective for your flight, you receive a mission completed message. Then, you can continue the mission in your aircraft or manually open the *Tactical Display* screen (press Esc) and select another plane in another flight. Then, click **FLY** to enter the other cockpit. Alternatively, use the keyboard shortcuts to switch cockpits.

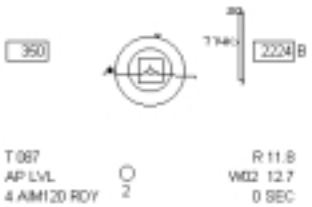
Esc	Toggle Tactical Display on/off. Click on an aircraft or flight button to select it, then click **FLY** to resume flight in the new aircraft/flight.
Shift 1 / 2 / 3 / 4	Switch to Flight 1, 2, 3 or 4

See **Interface: Aircraft/Flight Buttons**, p 1.20 for more details.

Advanced Avionic Options

DASH Helmet Display

The Israelis recently developed a helmet-mounted DASH display in order to speed pilot response time in close-quarters combat. The DASH helmet is a combination helmet and mounted optical sight. Its purpose is to help you keep track of important HUD data when you're looking in other directions. HUD information is projected onto the glass sight whenever you look away.



All data appears in the DASH helmet display appears normally in the HUD and/or MFD pages. However, you see only the boxed altitude and velocity readings, not the ladders.

The helmet auto-activates whenever the DASH system is available, and when the HUD isn't in view — i.e., when you're panning in the front cockpit view. (The DASH helmet is not available, however, in Vietnam-era aircraft.) It is especially effective when using SRMs. The seeker head automatically slaves to the DASH helmet display and tries to acquire the target in your DASH helmet view.

Night Vision Goggles

If you're flying at night, you have access to night vision goggles. They use light amplification techniques to enhance the view of the outside world. You must manually activate the night vision system. When it's active, you'll see black-and-green imagery through the front cockpit view and all panning camera views.

Ctrl N	Toggle night vision

Flyable Aircraft Cockpit Layouts

For an explanation of what these instruments do, see **Physical Gauges and Lights**, p. 2.10.

Dials and Gauges

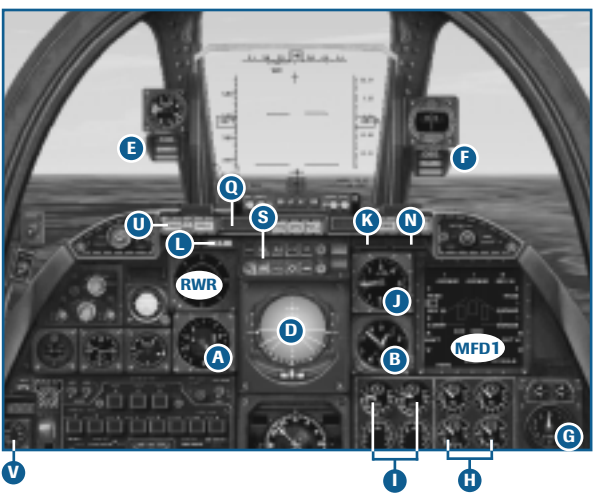
A. Airspeed indicator
B. Altitude indicator
C. Angle-of-attack (AoA) indicator (F-16C only)
D. Artificial horizon
E. Chaff counter
F. Flare counter
G. Fuel level indicator
H. RPM indicator(s) (twin-engined aircraft have left/right gauges)
I. Temperature gauge(s) (twin-engined aircraft have left/right gauges)
J. Variometer (rate of climb)

Lights

K. Air brake light
L. Autopilot light
M. Fire light(s) (twin-engined aircraft have two)
N. Flap indicator light
O. ECM light
P. Gear indicator lights
Q. Master caution light
R/S. RWR warning lights (SAM and aircraft locks)

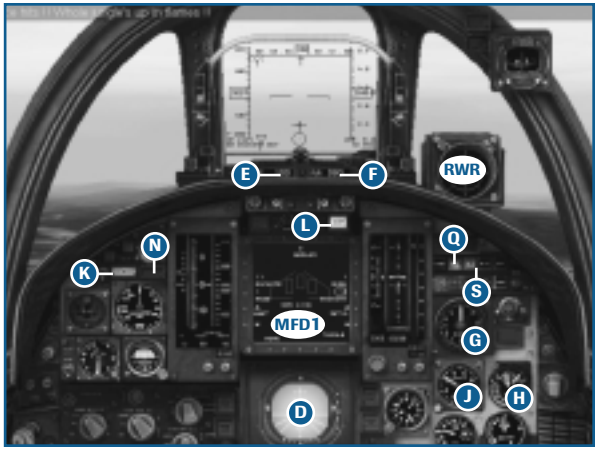
Switches and Levers

T. Autopilot button
U. Fire extinguisher button
V. Gear handle

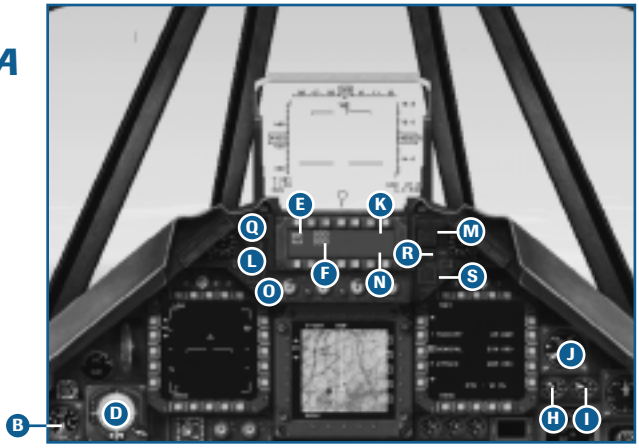


A-10A

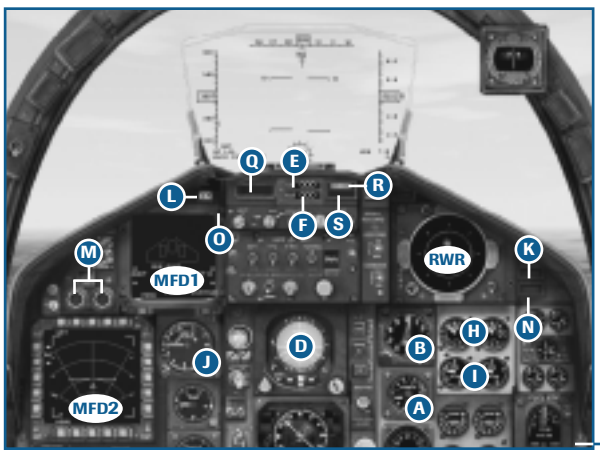
F-105D



F-117A



F-15C



Dials and Gauges

A. Airspeed indicator
B. Altitude indicator
C. AoA indicator (F-16C only)
D. Artificial horizon
E. Chaff counter
F. Flare counter
G. Fuel level indicator
H. RPM indicator(s)
I. Temperature gauge(s)
J. Variometer (rate of climb)

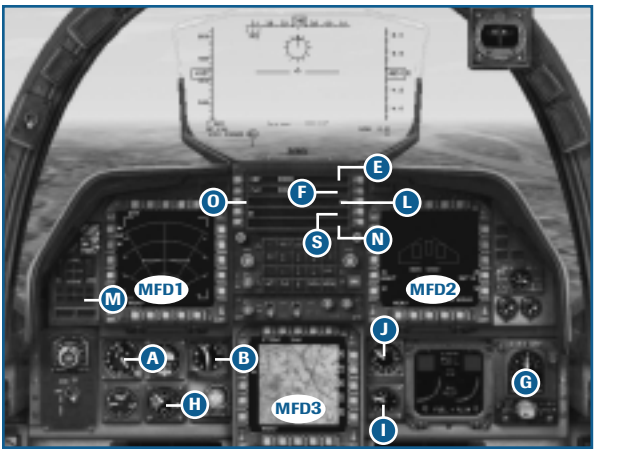
Lights

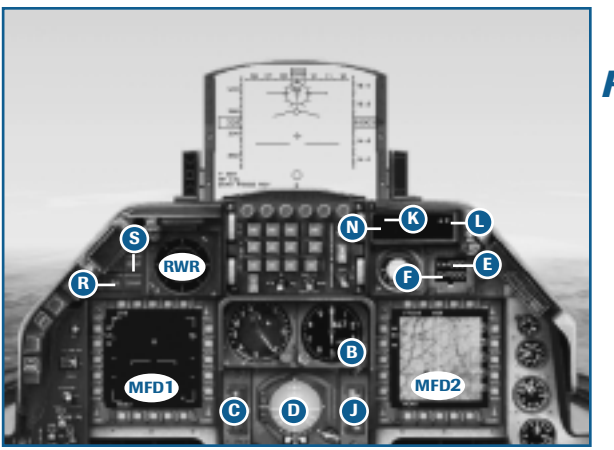
K. Air brake light
L. Autopilot light
M. Fire light(s)
N. Flap indicator light
O. ECM light
P. Gear indicator lights
Q. Master caution light
R/S. RWR warning lights (SAM and aircraft locks)

Switches and Levers

T. Autopilot button
U. Fire extinguisher button
V. Gear handle

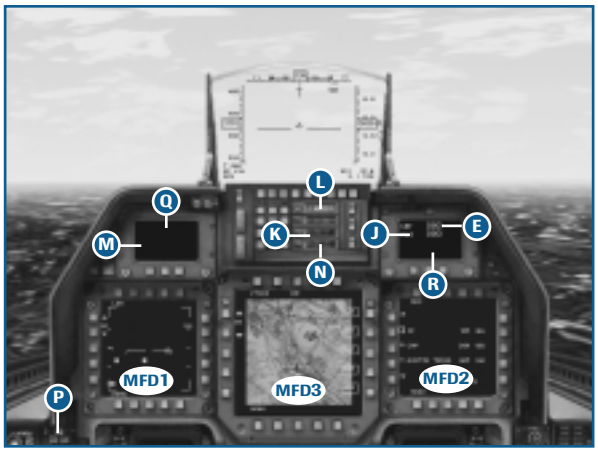
F-15E



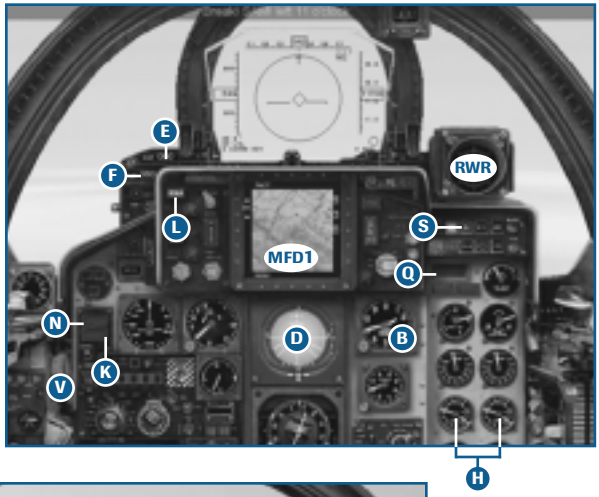


F-16C

F-22A



F-4E



MiG-29

PHYSICAL GAUGES AND LIGHTS

All aircraft maintain a set of backup gauges, in case the onboard computer becomes inoperable.

Dials and Gauges

A **Airspeed indicator.** Shows how fast the aircraft is traveling in *knots* of *indicated airspeed* (See **Flight: Airspeed**, p. 3.2, for definitions). Each tic mark on the dial indicates 100 knots, and the dial ranges from 0 to 900 knots.

B **Altitude indicator.** Shows barometric (Above Sea Level) altitude. Note that this is not equivalent to radar (Above Ground Level) altitude — see **Flight: Altitude**, p. 3.4, for definitions.

The long needle represents 100ft of altitude; the smaller one, 1000ft. The dial has ten tic marks, each measuring 100ft of altitude. Each time the long needle makes a complete revolution around the dial, the smaller needle rotates slightly clockwise to indicate another 1000ft of altitude.

C **Angle-of-attack (AoA) indicator.** (F-16C only) Shows current angle of attack (angle at which the wing is meeting the airflow). This gauge has a vertical scrolling ladder marked with tic marks in 5° increments, as well as a stationary, horizontal line. As your angle of attack changes, the ladder scrolls up and down, and the stationary line marks your current AoA.

D **Artificial horizon/Attitude Direction Indicator (ADI).** A ball indicator that rolls in all directions to show where the horizon is in relation to your aircraft's current pitch and bank angle. The ball is black below the horizon, and gray above it. The W-shaped break in the line represents your aircraft's position.

E **Chaff counter.** Lists how many chaff pods you have left.

F **Flare counter.** Lists how many flares you have left.

G **Fuel level indicator.** Displays amount of fuel remaining, in pounds.

H **RPM indicator.** Displays engine revolutions per minute — each tic mark on the dial represents 10% of maximum RPM. As RPM increases, the needle rotates clockwise. Twin-engined aircraft have one gauge per engine.

I **Temperature gauge.** Displays current engine temperature. The gauge markings range from 0 to 1200°. (Twin-engined aircraft have one gauge per engine.) The color of the dial changes according to engine temperature: *green* 400-800°, *yellow* 801-1000°, and *red* 1001-1200°.

Temperature readings are as follows:

400° Engine idling	*800°* Engine at afterburner 2
700° Engine at full military thrust	*1200°* Engine on fire
750° Engine at afterburner 1	

J **Variometer.** Shows rate of climb/descent, in ft/min. This gauge consists of a vertically scrolling ladder with tic marks every 500ft/min and a stationary, horizontal line indicating current rate of climb/descent. The reading on top of the stationary line is your current rate of climb.

Lights

K **Air brake light.** When lit, your air brakes are open. Open your air brakes when landing or if you need to quickly lose speed during combat.

L **Autopilot light.** When lit, your autopilot system is active (in either LEVEL or NAV mode). The current mode appears in the alphanumeric text on the left side of the HUD. See **Flight: Autopilot**, p. 3.14.

M **Fire light.** When lit, a fire in one of your engines. Twin-engined aircraft have a separate light for each engine. (Press [X] to use fire extinguisher.)

N **Flap indicator light.** Indicates whether your flaps are raised (up) or lowered (down). Lowered flaps change the shape of the wing, provide added lift and significantly slow your aircraft down. Lower your flaps ([F]) to gain extra lift at low speeds.

The light's color represents the current state of your flaps.

off	Flaps are up
green	Flaps are down
red or *yellow*	Flaps are in between the up and down positions

O **ECM light.** When lit, RWR jamming is active (press [J] to toggle jamming if available).

P **Gear indicator lights.** These three lights indicate the current position of your landing gear through their color. Press [G] to toggle gear up/down.

Color represents different gear states.

off	Gear is stowed in the up position
green	Gear is down and locked
red or *yellow*	Gear is in between the up and locked positions

Q **Master caution light.** Shows whether a main system is damaged (is "no go"). You can view the status of all systems in the **Damage MFD** ([D]), p. 2.47.

R **S** **RWR warning lights.** These two lamps light up when the radar warning receiver has detected a threat that has locked onto your aircraft, or a missile that has been fired at your aircraft. The *SAM lock warning light* (S) indicates a surface-to-air missile site has a lock on your aircraft. The *aircraft lock warning light* (R) indicates an air threat has a radar lock on your aircraft.

Switches and Levers

T **Autopilot button.** Toggles your autopilot system on/off. Press this button to cycle through the autopilot modes (off, NAV and LVL), or press [A]. Activating this button causes the autopilot lamp to light up.

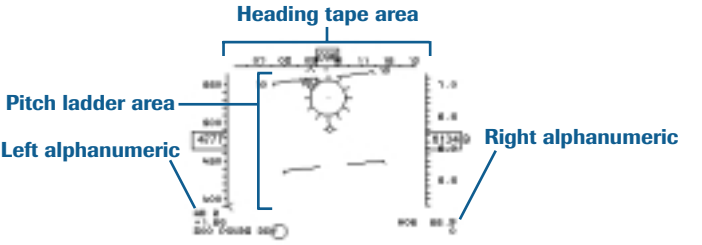
U **Fire extinguisher button.** Releases a fire extinguisher into an engine on fire. Left-click on this button to activate the extinguisher, or press [X].

V **Gear handle.** Lowers or stows your aircraft's landing gear. Left-click on this handle to toggle your landing gear up and down. Activating this button causes the landing gear lamp to light up.

HEAD-UP DISPLAY (HUD)

As introduced on p. 2.2, the Head-Up Display (HUD) is a collection of information displayed on a glass panel in the front of your cockpit, including current flight data, weapon guidance aids and target information.

The HUD can be divided into four regions — the *heading scale* across the top, the *pitch ladder* through the center and *alphanumeric* information to the left and right. No matter what HUD submode is active, these regions always appear.



Heading scale area. Displays the direction in which the plane is headed. In the center, a three-digit number indicates the exact heading. A small caret appears below this scale to indicate the bearing of the currently selected waypoint. If the waypoint is off the scale, several arrows appear and point in the direction of the waypoint.

Pitch ladder area. Shows information about your aircraft's bank angle, airspeed, altitude, and angle of attack. Also displays weapon targeting aids. The contents change depending on the HUD mode and currently selected weapon.

Left alphanumeric area. Contains important information such as thrust and selected weapon. The contents change depending on the HUD mode.

Right alphanumeric area. Contains information such as waypoint data or target info. The contents change depending on the HUD mode.

HUD Key Commands

The HUD is mostly a display device — you don't actually *do* much of anything to it. The major interactive function of the HUD is that its mode changes depending on what master mode is selected. When you switch master modes, your HUD, MFD, radar and weapons are optimized for a particular task.

[N] Activate Navigation HUD

The HUD information is sometimes too hard to see against different backgrounds. For this reason, you can adjust the color of the HUD to make it easier to read:

[H] Cycle through HUD colors (GREENS / WHITE / RED / YELLOW)

Master Mode Settings

The table below shows what HUD mode, radar mode, weapons setting and MFDs are activated in each master mode.

	NAV	Air-to-Air	Air-to-Ground
Active MFDs	Tactical Radar NAV	Radar Tactical RWR	Radar Tactical RWR
HUD mode	NAV	AA	AG
Radar mode	air-to-air	air-to-air	air-to-ground
Available weapons	none (gun is active if gear is stowed)	Medium-range missiles*	General-purpose bombs*

Note: *If you're flying an F-22A, F-117A, and F-15C or F-15E, the JTIDS MFD replaces the Tactical Map or RWR MFD. See p. 2.40 for details on this display.*

* Active by default

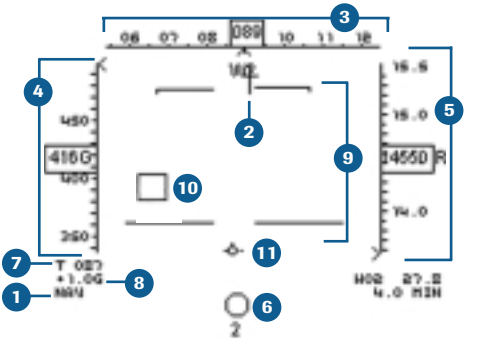
If your cockpit contains three MFDs, you see all of the MFDs listed above for the appropriate modes. If you have only two MFDs, you see only the first two MFDs listed, and if you have one MFD, you see only the first listed.

- For details on HUD symbology, see **Head-Up Display**, p. 2.12.
- For details on MFDs see **MFD Pages**, p. 2.29.
- For details on radar modes, see **Radar MFD Page,** p. 2.31 and **Combat: Using the Radar**, p. 4.12.
- For more details on using weapons, see **Combat: Using Weapons**, p. 4.28.

Common HUD Information

Common HUD element callouts are numbered 1-11. Each master mode — Navigation, AA and AG, plus their HUD submodes — continues this numbering individually. (Each starts at 12 and counts upward.)

Although the HUD has many modes, some information appears in every mode. Those elements are described here. Other elements are specific to a particular mode. Please see the appropriate HUD mode section to find out what other information appears.



1. **Current weapon/HUD mode.** In AA and AG HUD modes, displays your currently selected weapon, number of this weapon remaining and the weapon's status. (See **Combat: Using Your Weapons**, p. 4.28, for details.) In NAV HUD mode, NAV appears.

2. **Gun cross.** Small cross in the center of the HUD that represents where your gun is aimed. This displays no matter what weapon you have selected.

3. **Heading scale.** The heading scale is essentially a compass. North is 360, east is 090, south is 180 and west is 270. The stationary box in the center of the scale gives your current heading. A caret below the scale marks the heading to your current waypoint

4. **Airspeed ladder.** Displays airspeed — each tic mark on the *vertical ladder* represents 10 knots of airspeed. Numbers to the left of the tic marks indicate 100-knot increments. As airspeed changes, the ladder scrolls up and down. The stationary box centered on the scale shows current airspeed.

Note: *"**T**" appears next to the airspeed reading in the box in the AG HUD when true airspeed is shown. "**G**" appears in the NAV HUD modes when ground airspeed is shown. "**I**" appears in the AA HUD when indicated airspeed is shown. For definitions of these airspeed measurements, see* ***Flight: Airspeed****, p. 3.2.*

- In NAV mode, a sideways *velocity caret* scrolls up and down with the ladder and shows how fast you need to fly to reach the next waypoint on schedule.

5. **Altitude ladder.** Indicates your altitude — each tic mark on the *vertical ladder* represents 100ft of altitude, and the numbers to the right of the tic marks indicate 500ft increments. As altitude changes, the ladder scrolls up and down. The box in the middle of the scale shows your current altitude.

- In NAV mode, a sideways *altitude caret* scrolls up and down with the ladder and shows the planned altitude for this leg of your flight.

***Note:** "**B**" appears next to the altitude reading in the box in AA HUD mode, when barometric altitude, or altitude above sea level (ASL), is displayed. "**R**" appears in NAV and AG HUD modes, when radar altitude, or altitude above ground level (AGL), is displayed. For an explanation of these different altitude measurements, see **Flight: Altitude**, p. 3.4.*

6 **Current waypoint.** Shows the direction to your currently selected waypoint. Circles indicate ordinary waypoints — the number next to the circle is the number of the current waypoint (1, 2, etc.). Triangles indicate target waypoints — a "T" inside of a triangle indicates a waypoint with a mission-critical target you're supposed to attack. (In NAV mode, the *alphanumeric text* on the right side of the HUD lists additional information about range and time-to-arrival — see **Navigation HUDs** p. 2.16).

7 **G-force reading.** How many Gs your aircraft is currently pulling (positive or negative). See **Flight: Load Factors and G-Forces**, p. 3.5, for details.

- If the autopilot system is active, the G-force reading is replaced by the current autopilot mode — off, level (LVL), navigation (NAV) or refuel (RFL).

8 **Thrust.** Your aircraft's current throttle setting, displayed as a percentage of your maximum RPM (100%). You can increase and decrease thrust with a throttle device or by using the following key commands:

0-9 These keys control throttle. See **Flight: Throttle**, p. 3.9, for details.

9 **Pitch ladder.** Indicates how far your aircraft's nose is pitched up or down. The longest line appears when you're flying level (i.e., at 0° of pitch). The lines above and below this represent 5° of pitch (above is positive, below is negative); the brackets at the ends of the lines point toward the horizon (0° pitch line). The lines are labeled numerically every 10°.

10 **Target designation (TD) box.** This square box appears when you have a target locked. If the target is within the HUD field of view, the TD box surrounds it. The TD box moves to the edge of your HUD when the target is out of HUD field of view but still in radar range. If the target falls out of the field of view, the lock breaks and the TD box disappears. For details on acquiring targets, see **Combat: Targeting the Enemy**, p. 4.23.

- If you activate the EASY TARGETING option in the *Preferences* window, you can maintains your lock on a target, even when it moves out of your view. The TD box also remains onscreen and floats outside the HUD in the direction of the target.

- If you ENABLE CHEAT RADAR in the *Preferences* window, you can maintain a radar lock on any threat in a 360° radius around your aircraft.

11 **Velocity vector.** Indicates the direction in which your aircraft is traveling (its current flight path). If you make a hard maneuver (i.e., bank or climb sharply) your aircraft may be pointed in one direction, but moving in another. The velocity vector always marks the actual direction of travel, not the direction in which your aircraft's nose is pointed.(The *vertical line* represents your aircraft's tail position; the *horizontal lines* represent your wings.)

Navigation HUDs

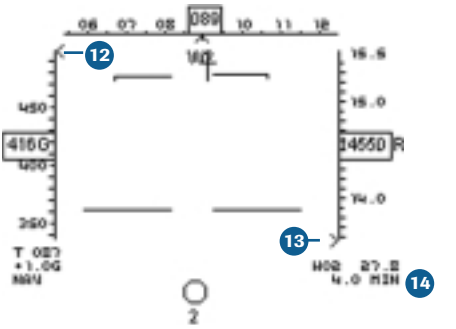
*See **Common HUD Information**, p. 2.14, for additional HUD elements.*

Navigation mode is the mode you'll use whenever you're not in combat. For most flight in non-combat areas, put the HUD in NAV mode to aid you in moving between waypoints. Be sure your radar is in a mode suitable for the environment, either AA for air-to-air missions (default) or AG for air-to-ground missions.

[N] Activate Navigation HUD mode

When the HUD is in NAV mode and you are making an approach to land, the Instrument Landing System (ILS) information displays on HUD. When you're re-fueling in mid-air, the Refueling information appears.

Navigation HUD Information



12 Velocity caret. Small, sideways triangle that scrolls up and down the Airspeed ladder and shows how fast you must fly to reach the next waypoint by your scheduled time-to-arrival.

13 Altitude caret. Small, sideways triangle that scrolls up and down the Altitude ladder and shows the prescribed altitude for flying to your next waypoint.

14 Estimated Time-to-Arrival (ETA). How long it will take to reach the currently selected waypoint at your current airspeed. This information appears in the *alphanumeric text* on the right side of the HUD.

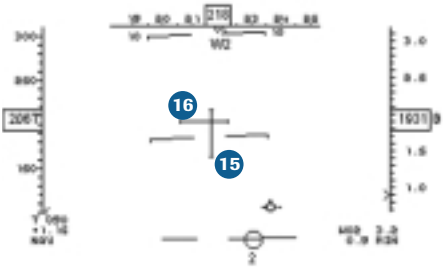
- The *top line* lists the current waypoint and its range — "W02 27.8" indicates you're 27.8nm away from Waypoint 2.
- The *second line* indicates the time it will take for you to reach the waypoint in minutes and seconds. For instance, "4:0" indicates four minutes.

Instrument Landing System HUD

This HUD activates automatically when your landing gear is down and the NAV HUD is active. When you're within 10nm of the runway, it provides onscreen cues to help guide you onto the runway.

*The Landing training mission is a detailed, real-time tutorial that takes you through the landing process. (See **Training Screen**, p. 1. 8.) See **Flight:Landing** (p. 3.19.) for step-by-step landing instructions.*

15 Localizer deviation bar. This is a vertical "I-shaped" line. It drifts left and right to indicate your aircraft's approach relative to the center of the runway. Align the velocity with this line. (If you do this, you are flying on the glide path — about 3° to 4° of pitch.)



16 Glide slope deviation bar. This is a horizontal "I-shaped" line. It drifts up and down to indicate your aircraft's altitude with respect to the runway. Centering this bar and the localizer bar on top of the velocity vector essentially forms a cross symbol centered on the velocity vector. If the velocity vector is above this line, you're flying too high.

Note: If the needles lines are dashed, and all cues are centered in the HUD, you're not receiving ILS information. For the cues to appear, you must be within 10nm of the runway and maintain the correct descent rate.

Refueling HUD

The Mid-Air Refueling training mission is a detailed, real-time tutorial that takes you through the refueling process. (See ***Training Screen****, p. 1. 8.) See* ***Flight: Manual Mid-Air Refueling*** *(p. 3.16) for step-by-step refueling instructions.*

Refueling information appears on the HUD when it is in NAV mode and you open the fuel hatch (Ctrl R). The Refuel HUD display is similar to the NAV HUD display with one addition:

Current refuel status. Audio cues from the boom operator describe the current refueling stage:

READY	Hatch is open and ready for fueling
CONTACT	Boom is connected and fuel is flowing
FULL	Tanks are full
DISCONNECT	Disconnect has started.

Note: *You can refuel on autopilot by pressing* A *after you open the hatch (*Ctrl R*). Make sure* RFL *appears in the HUD. See* ***Flight: Using Autopilot for Mid-Air Refueling****, p. 3.15.*

You can also select the UNLIMITED FUEL *option from the* Preference *window in order to never run out of fuel. See* ***Appendix D: Preferences Window****, p. 8.8.*

Air-to-Air (A/A) HUDs

*See **Common HUD Information**, p. 2.14, for additional HUD elements.*

The air-to-air HUD modes are geared toward combat situations with other aircraft. Four different HUD submodes are available, and the correct mode activates when you select a particular weapon. Two are gun modes that require your air-to-air radar to be active (LCOS and EEGS), and the other two are guided missile modes (SRM and MRM).

- [M] Toggle avionics master mode (Navigation / Air-to-air / Air-to-ground)
- [ ]] Cycle through air-to-air weapons (or, press associated hardpoint pushbutton in Stores MFD — see p. 2.41.)

This section discusses the symbology used in the four A/A HUD submodes. Please see **Combat: Using Weapons** (p. 4.28) for details on how to acquire targets and use different weapons.

*For step-by-step firing instructions, see **Combat: How to Fire Guns**, p. 4.37.*

Lead-Computing Optical Sight (LCOS) HUD

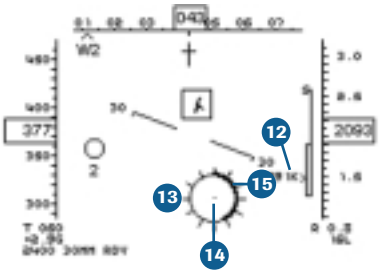
Firing guns and hitting a target at anything but point-blank range can be difficult. However, all aircraft have a radar-aided gun sight to help you make a successful gun attack on a target aircraft.

Your gun is always active. Plus, if you are in A/A master mode, the Lead-Computing Optical Sight (LCOS) HUD appears. This mode uses your onboard air-to-air radar to track and acquire targets. It automatically attempts to acquire any targets flying through your front view.

This HUD displays a circular pipper symbol that drifts around in the HUD. When you have a target locked, the pipper's position is constantly updated through calculations involving the target's speed, range and G-force. It shows where you should aim in order to land a hit on a locked target. Firing shots in your target's anticipated flight path is called "leading" the target.

Move the pipper over the target. Hold fire until the target moves within gun range and you have a good aspect angle to the target. At about 2nm away from the target, a full dark arc forms around the pipper and starts decreasing in length. The shorter the arc, the closer the target.

- [Enter] Cycle through available targets
- [Q] Cycle through air-to-air radar submodes (LRS / TWS / ACM) (or press PB16 on the Radar MFD in air-to-air mode — see **Radar MFD page**, p. 2.31)
- [\] Activate Boresight radar submode (press and hold). (Radar locks into first target to enter your HUD view)

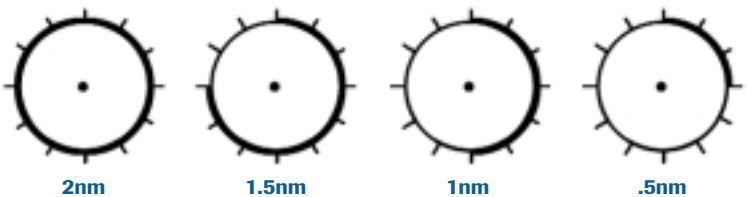


12 Closure speed. How fast you're closing in on the target (or how fast it's flying away from you) in knots. The third line of alphanumeric text on the right side of the HUD gives the range as positive (closing in on the target) or negative (opening up space on the target). For instance, +400 means you're closing in quickly on a target, while –30 means the target is slowly pulling away from you.

13 Reticule. Medium-sized circle drifting in the HUD. It shows where to lead your shots.

14 Pipper. Small, circular aiming cue that aids in firing guns at a locked target. It is located in the center of the reticule. When you move the pipper/reticule over the target and fire, you have the best chance of hitting the target.

15 Range arc. When the target is approximately 2nm away (the maximum range for most guns), a dark arc appears on top of the pipper The arc decreases in radius as you close in on your target. Each small tic mark around the reticule indicates 900 feet of distance. The size of the arc represents target distance:



15 Gun cross. Small cross in the center of the HUD that represents where your gun is aimed. This displays no matter what weapon you have selected.

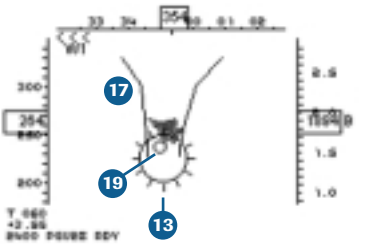
Enhanced Envelope Gun Sight (EEGS) HUD

For step-by-step firing instructions, see ***Combat: How to Fire Guns****, p. 4.37.*

Some aircraft have a secondary radar-aided gunsight called the Enhanced Envelope Gun Sight (EEGS). Similar to the LCOS gun sight, it places a cue on the HUD to help you gauge a target's range and lead your bullets. However, it uses a funnel structure instead of a circular pipper, and gives you more information.

Enter Cycle through available targets

Q Cycle through air-to-air radar modes (LRS / TWS / ACM) (or press PB16 on the Radar MFD in air-to-air mode — see **Radar MFD Page**, p. 2.31)



13 Reticule. Medium-sized circle that drifts in the HUD and shows you where to lead your shots. It replaces the Target Designation box when the air radar is active and you've locked onto a target.

The reticule in the EEGS gun sight has a function similar to the range ladder in the LCOS gun sight. When the target is approximately 2nm away, the reticule is a full circle. Small tic marks around the reticule indicate 300 meters of distance. As you get closer to the target, the circle turns into an arc that decreases in radius. The length of the arc represents target distance (see diagram on p. 2.19).

14 Pipper. (Not shown; BATR replaces this in example diagram) Small aiming dot cue that aids in firing guns at a locked target. When you move the pipper over the target and fire, you have a good chance of hitting it.

15 Range arc. (Not shown; see diagram on previous page) When the target is approximately 2nm away (the maximum range for most guns), a dark arc appears on top of the pipper The arc decreases in radius as you close in on your target. Small tic marks around the reticule indicate 900 feet of distance. The size of the arc represents target distance (see diagram on previous page).

17 **Funnel.** Two lines in the shape of a funnel showing the path of your bullets. The funnel's shape twists and changes as you and the target maneuver during a dogfight to gain a firing solution.

The funnel represents a 35ft wingspan target at ranges between 200 meters (the wide end of the funnel) and 1nm (the narrow end of the funnel). If your target's wings "fit" in between the funnel lines on the skinny end of the funnel, for example, he's 250ft away. The EEGS funnel also shows the path your bullets follow. When you fire, the bullets start out in the approximate center of the funnel.

The small mouth of the funnel shows where your bullets will be once they travel 1 nautical mile (which is why you should line small, long-distance targets up on this end of the funnel). The large mouth shows where your bullets fall after traveling 200 meters.

- In general, line the target up inside the funnel so his wingspan touches both sides of the funnel.

18 **G-force pipper (+ / –).** (Not visible in this diagram) Displays an axis along which you should aim if the target suddenly increases or decreases its G-force. This "pipper" actually consists of a "+" and "–" symbol. The "+" symbol shows where bullets will fall if the target quickly pulls 9Gs, and the "–" symbol shows where bullets land if the target's G-force falls to 1G.

- If you can see your target pulling a high-G maneuver, aim the normal pipper slightly more toward the "+" symbol.
- If the target looks like it's losing Gs quickly, aim slightly toward the "–" symbol.

19 **Bullets at Target Range (BATR).** A small circle with a dot in the middle showing where your bullets are once they reach the target's range. If the target is at 500m, the BATR cue appears once the bullets have traveled 500m.

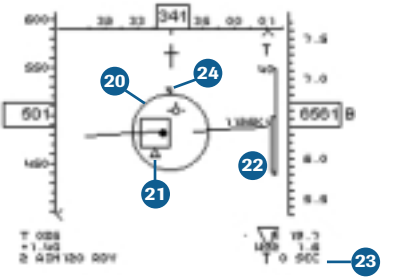
Medium-Range Missile (MRM) HUD

For step-by-step firing instructions, see ***Combat: How to Fire Radar-Guided Missiles****, p. 4.41.*

The aircraft in this game can carry many types of medium-range, air-to-air missiles — USAF planes carry the AIM-7B, AIM-7F, AIM-7M and AIM-120, while Russian planes carry the AA-6 and AA-10. All of these missiles are radar-guided. Some use your aircraft's radar to track targets until impact (SARH — semi-active radar homing), while others have built-in seeker heads. The HUD symbology is almost identical for all of the missiles; exceptions are noted below.

Enter Cycle through available targets

Q Cycle through air-to-air radar submodes (LRS / TWS / ACM) (or press PB16 on the Radar MFD in air-to-air mode — see **Radar MFD Page**, p. 2.31)



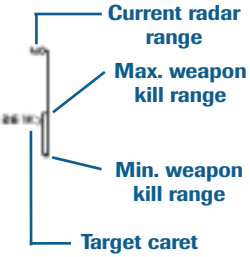
20 ASE circle and steering dot. The Allowable Steering Error circle and dot provide a steering reference when you are tracking your target with radar.

The *circle* graphically illustrates the seeker head's effective field of view. The size of the ASE circle changes as a function of target range, altitude and aspect angle. As you close in on your target, the ASE increases in size to a certain point, then may decrease depending on target aspect. A larger circle indicates a better chance of a hit.

The *solid dot* indicates where the missile would impact if you fired it immediately. Its position is calculated using the missile's performance statistics and the target's range, aspect angle and speed. Before firing, maneuver to place this dot inside the ASE circle. You can fire the missile without doing so, but you'll probably miss the target.

21 Shoot cue. This flashing symbol appears beneath the TD box when your target is within weapon range and the aim dot falls inside the ASE circle. The shoot cue indicates that the weapon is in its dynamic launch zone (DLZ).

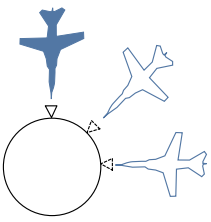
22 **Dynamic Launch Zone (DLZ).** A small ladder scale indicating your missile's range and the target's current range in relation to your radar's maximum range. The vertical line represents the radar's range. The number above the line represents the currently selected radar range. The shorter, offset line shows the maximum weapon kill range for your currently selected air-to-air missile. The number and the small caret to the left of the line show the target and its closure speed.



When the target caret slides within the weapon's kill range line, you can fire your weapon.

23 **Estimated Time-to-Impact (ETI).** How long it will take the missile to fly to the target and detonate. "2 SEC," for instance, means it will take two seconds to impact. This reading appears just below the DLZ.

24 **Analog/digital target aspect angle.** Cue showing which aspect of the target is facing you.



The *triangle* rotates around the ASE circle and lets you know where the target is in relation to you. If it's at the top of the circle, you're facing the target's nose head-on (180° aspect angle). If it's on the right (the 3 o'clock position), you're facing the target's left wing (90° aspect angle)..

The *alphanumeric text* on the right side of the HUD also indicates the target aspect angle, but uses degrees and letters. It appears on the third line of text. An aspect of T indicates you're facing your target's tail (0°); H indicates you're facing his nose (180°). An aspect of 16R indicates you're facing a point between the aircraft's nose and its right wing. 9L indicates you're facing the pilot's left wing.

25 **Break X.** (Not shown) A large "X" replaces the ASE and flashes when you are too close to fire (i.e., inside the missile's minimum range).

Short-Range Missile (SRM) HUD

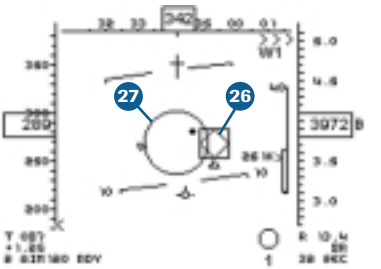
For firing instructions, see ***Combat: How to Fire IR-Guided Missiles****, p. 4.43.*

The SRM HUD mode automatically activates whenever you select a short-range, IR-guided missile — AA-8, AIM-9L, AIM-9M, AIM-9P or AIM-9X. These missiles use built-in seeker heads to detect and follow a target's heat source. You need to have your air radar active in order to gain an initial lock on a target. After that, the IR seeker head will try to lock on to that target.

Enter Cycle through available targets.

Q Cycle through air-to-air radar modes (LRS / TWS / ACM) (or press PB16 on the Radar MFD in air-to-air mode — see **Radar MFD Page**, p. 2.31)

Cues that are different from those that appear in the Medium-Range Missile (MRM) HUD (previous page) are described here:



26 SRM (IR) seeker head. Small, diamond-shaped cue representing the seeker head's boresight. It has four different acquisition modes that change:

Caged mode is initially active. You don't have a target locked on radar. The seeker head is not detecting any heat source and the seeker cue sits in the middle of the HUD. If a heat source (target) moves within the boresight, the seeker head attempts to acquire a lock on the target.

Radar slaved mode becomes active when you have a radar-locked target, but the seeker can't yet detect the heat source. The missile slaves to the radar LOS and tries to acquire the radar target.

Helmet slaved mode activates when you press the boresight key (\). The missile follows your helmet view and tries to acquire the heat source you're looking at.

Acquisition mode activates once a heat source is detected in any of the previous modes. The missile's seeker head locks onto the heat source and follows it as long as you maintain lock and keep the target within the seeker head's field of view. At that point, the missile tone changes. If you switch radar targets at this point, the seeker returns to radar-slaved mode.

27 IR seeker circle. Large circle indicating the field of view for the missile's seeker head. If a target falls within this circle and is in range, the seeker head tries to gain a lock on its exhaust pipes. The circle is large when you don't have a target, but shrinks in size when you acquire a lock.

Air-to-Ground (A/G) HUDs

*See **Common HUD Information,** p. 2.14, for additional HUD elements.*

The air-to-ground HUD modes are designed to help you use your gun, air-to-ground missiles and bombs against ground targets. Each mode corresponds to a particular type of weapon — STRF for guns, TV for TV-guided-missiles, and CCIP for bombs. The correct mode activates when you select a particular weapon. By default, the Strafe HUD appears if you don't have any other AG weapons loaded.

[M] Toggle avionics master mode (Navigation / Air-to-air / Air-to-ground)

[[ ] Cycle through air-to-ground weapons (or, press hardpoint pushbutton in Stores MFD, see p. 2.41)

***Note:** Though they don't have specific HUD symbology, laser-guided bombs do display a special TD box on the HUD. It has small lines that show the LANTIRN's camera position. See **TV-Guided Missile (TV) HUD** (p. 2.28) for details.*

Strafe (STRF) HUD

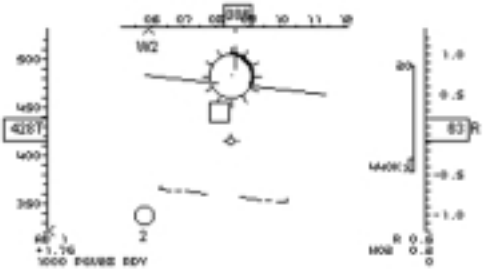
*For step-by-step firing instructions, see **Combat: How to Fire Guns**, p. 4.37.*

When the radar is in A/G mode and you have guns active, the Strafe HUD appears. It follows either moving ground targets you have locked (in GMT mode) or stationary targets (in MAP mode). Like the A/A gun LCOS gun sight, the Strafe HUD displays a circular pipper symbol that drifts around in the HUD. Position the pipper over the target. At about 2nm away from the target, a full dark arc forms around the pipper and starts decreasing in radius. The shorter the arc, the closer the target (see diagram on p. 2.19).

[Enter] Cycle through available targets.

[Q] Cycle through air-to-ground radar modes (MAP / GMT). (Or press PB16 on the Radar MFD in air-to-ground mode — see **Radar MFD Page**, p. 2.31.)

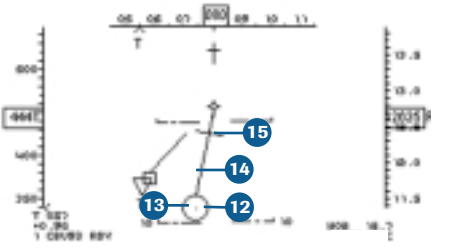
Cues on the HUD in Strafe mode are the same as for the HUD in LCOS mode, except that closure speed is not reported. See p. 2.18 for definitions.



Continuously Computed Impact Point (CCIP) HUD

For instructions on bombing, see ***Combat: How to Drop Unguided Bombs****, p. 4.46.*

The CCIP bomb HUD is a computed, manually initiated release mode. Use it to deliver general-purpose (GP) and laser-guided (LGB) bombs. The computer constantly calculates the anticipated impact point and displays a pipper/reticule on the HUD. You control the timing of weapon release, and you do not have to have target lock before you "pickle" (drop your bomb).



12 **Reticule.** Medium-sized circle that drifts in the HUD and shows the general area where the bomb will hit if released immediately. It replaces the TD box when the ground radar is active and you've locked onto a target. Altitude over the target is used to compute bomb range and symbology.

13 **Pipper.** Dot centered within the reticule. It reflects the bomb's calculated impact point. When you move the pipper/reticule over the target and release the bomb, you have the best chance of hitting the target. If you've selected a ripple setting, the pipper marks the average impact point for all weapons.

The CCIP pipper enters one of two modes when you release the weapon, depending on whether the calculated impact point is in the HUD view:

In *immediate CCIP mode* (default), the pipper/reticule indicates the bomb's predicted impact point at that instant. It remains active when the calculated impact point is visible in the HUD.

Delayed CCIP mode is used when the impact point can't be shown on the HUD due to high altitude, shallow dive angle, low speed, or high angle of attack. (If released, the bomb's impact point would fall outside the HUD.) Delayed CCIP mode solves this by displaying a delayed pipper. You still release the bomb when the pipper is over the target, but the drop is delayed. The delay is calculated by the aircraft's computer and considers dive angle, airspeed and AGL altitude. More HUD symbols appear (described later).

- Press the pickle button (Spacebar or joystick button 2) when the reticule centers on the target area. (If you've locked a target, align the reticule with the TD box.) When you press the pickle button, the pipper point becomes the designated target and the pipper recenters on the pickle point.
- Hold down the pickle button. The bomb fall line is initially solid, but flashes once you press the button. It continues flashing until the bomb is released. Once it quits flashing, you can release the pickle button.

14 **Bomb fall line.** Line connecting the pipper to the velocity vector circle. This line flashes once all bombs are released. If you're in delayed CCIP mode, a delay indicator appears on this line. In that case, you must keep the pickle button depressed until all cues start flashing.

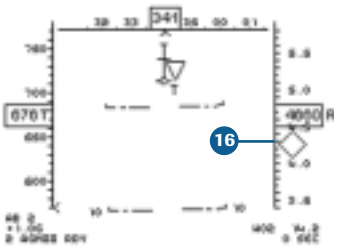
15 Delay indicator. Horizontal line that slides down the bomb fall line toward the pipper. It starts out at the far end, representing a 10-second or longer delay between pickle/release. As range decreases, the delay cue "falls" down the line toward the pipper (representing a shorter delay). This is a countdown cue of sorts — it starts falling at 10 seconds to release. Once the delay line crosses the velocity vector, your bombs drop.

- If you're ripple-firing, keep the pickle button depressed until all cues flash.

HARM HUD

*For instructions on HARMs, see **Combat: How to Fire HARM Missiles**, p. 4.42.*

When HARM missiles are active, the HARM MFD activates and a diamond-shaped seeker head appears on the HUD. This missile seeker initially drifts in the HUD, but then slaves to any target you left-click on in the HARM MFD. (Meanwhile, you can still cycle through radar targets and gain a new radar lock without affecting the HARM seeker or lock.



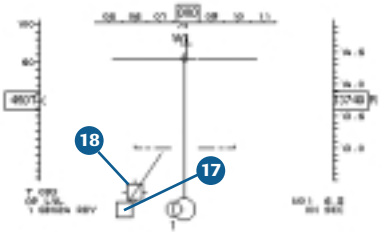
Press Spacebar or joystick button 2 to fire a HARM missile once "IN RANGE" appears in the HARM MFD (see p. 2.46).

16 Seeker head. Diamond showing where the seeker head is currently aimed. It slaves to a target you click on in the HARM MFD (see p. 2.46).

Laser-Guided Bomb HUD

*For instructions on LGBs, see **Combat: How to Drop Laser-Guided Bombs,** p. 4.48.*

When you select a laser-guided bomb as your current AG weapon, the FLIR MFD displays and additional symbology appears on the HUD. (Some symbology is similar to what appears in the CCIP HUD — see facing page.)



When the laser is on (press L), an icon appears on the HUD and indicates where the LANTIRN's FLIR camera is currently looking. If you've left-clicked in the AG Radar MFD to designate a target point, it appears on the HUD as well. A FLIR image of the target area displays in the FLIR MFD (p. 2.46), regardless of whether or not the laser is active.

17 Current LANTIRN position. Indicates where the FLIR camera and the laser designator are pointing. It slaves to the LANTIRN's current position.

18 Current laser designation. Shows a laser spot you've designated in the AG Radar MFD. To adjust the designation, press Ctrl and ←→↑↓.

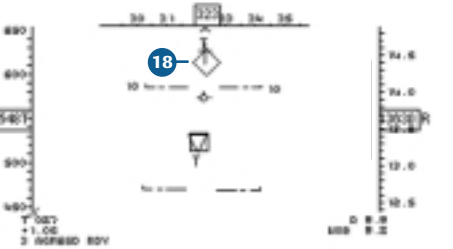
TV-Guided Missile (TV) HUD

*For firing instructions, see **Combat: How to Fire TV-Guided Missiles**, p. 4.44.*

The TV-Guided Missile HUD assists you in launching TV-guided bombs (GBU-15, AGM-62) and missiles (AGM-62, AGM-65B, AGM-130) and image infrared IIR missiles (AGM-65D). Cameras in the seeker heads of these weapons display a television (or IIR) image in the TV Missile MFD. The seeker head is capable of looking 30° left and right, 15° up and 45° down.

Some image-guided weapons are FLIR missiles. For instance, Maverick (AGM-designated) missiles automatically home in on a high-contrast FLIR image. GBU- and Popeye-series bombs use TV imagery and require manual steering.

18 Camera indicator diamond. Shows the current camera line of sight for the selected weapon. The center of the diamond corresponds to the center of the camera view. An image of what the camera sees appears in the TV Missile MFD.



- Position the camera indicator diamond over the Target Designation (TD) box.
- For weapons requiring manual steering, press Ctrl and ←→↓↑. This lets you control where the camera is looking. Try to center it over the target.
- When you're in the missile's kill range, READY appears on the HUD next to the altimeter ladder.
- If an area is relatively SAM-free after you've released a manually guided weapon, you can toggle to the egress waypoint, then activate autopilot (NAV mode). This leaves you free to concentrate on steering the missile or bomb, and points you toward your exit waypoint.

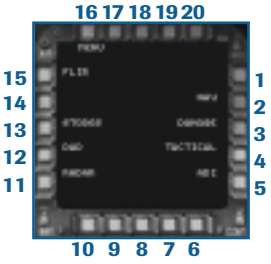
MFD PAGES

Multi-Function Displays (MFDs) display "pages" of information. Most cockpits have two MFDs, though some have one or three. You can display different pages of information in any MFD. Not all MFDs appear in all aircraft.

Pushbuttons around the perimeter of each MFD perform different functions, depending on the page currently displayed. Left-click on a pushbutton to use it. The name of the current MFD page appears in the corner near PB 16.

Menu Page

When you click MENU (PB10) in the bottom left corner of any MFD screen, the *Menu* screen appears. This general screen lets you display a specific MFD. Left-click on the pushbutton next to an MFD name to open it.



Key	PB#	Name	Function
N	PB2	NAV	Displays waypoint information.
D	PB3	DAMAGE	Displays current system status (damage/no damage).
n/a	PB5	ADI	Displays an artificial horizon and altitude reading.
T	PB4	TACTICAL	Displays map and waypoint information.
T	PB4	JTIDS	Displays map and combined data from radar, RWR, JSTARS and AWACS. It shows friendly status, friendly and enemy radar locks, and air and ground targets (F-22A, F-117A, F-15C, F-15E or F-16C only)
R	PB11	RADAR	Displays radar picture (contact information) for the air-to-air and air-to-ground radars.
U	PB12	RWR	Displays radar warning receiver. (Available as a separate instrument in some aircraft.)
n/a	PB13	STORES	Automatically displays when in CCIP mode. Displays hardpoint status, available weapon types and counts. Also lets you select ripple-fire settings and bomb delivery mode.
I	PB15	FLIR	Automatically displays LANTIRN, FLIR and targeting information for IR- and laser-guided weapons.
n/a	n/a	TV	Automatically displays optical and target information necessary for firing TV-guided missiles.
n/a	n/a	HARM	Automatically displays optical and target information necessary for firing HARM missiles.

NAV MFD Page

*For instructions on navigating between waypoints, see **Flight: Navigation**, p. 3.11.)*

This MFD lists navigational data about the currently selected waypoint, and lets you switch to any other waypoint in the mission. Most of this information displays on the HUD when you're in NAV mode — press N to access this mode and display the NAV MFD.

Here, you can review the waypoints for your mission. The navigational computer constantly updates waypoint information in this MFD. You can see the miles and bearing measures change as you fly. The target (mission objective) waypoints are usually named TARGET. For a clear view of how waypoints are positioned relative to each other, press Esc to jump to the *Tactical Display* screen (see **Interface: Tactical Display Screen**, p. 1.15).

Only three waypoints display at any one time, and your current waypoint is always at the top and boxed. You can use the pushbuttons to scroll through the waypoint list.

PB15 / PB16 Scroll forward / backward one waypoint

W / Shift W Alternatively, use the keyboard.

- If you're in Autopilot NAV mode, the aircraft automatically flies toward the selected waypoint. (See **Flight: Autopilot**, p. 3.14).
- The current waypoint heading displays as an inverted caret on the heading scale and indicates the bearing to the next waypoint.

Waypoint number/name. List of numbered navigational waypoints. Those with mission-critical targets are usually labeled TARGET. The top line is always the current waypoint, and its number is boxed.

Waypoint bearing. Compass heading for the waypoint, a three-digit number ranging from 001 to 360. 360 indicates due north, 090 due east, 180 due south, and 270 due west.

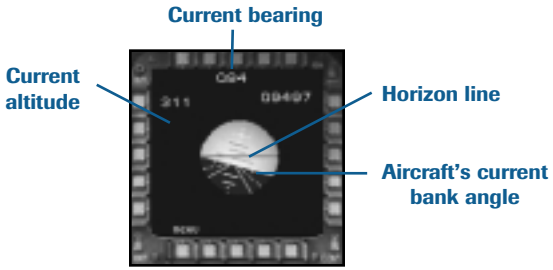
Waypoint distance. Distance in nautical miles to the currently selected waypoint.

Estimated Time-to-Arrival (ETA). How long it will take to reach the currently selected waypoint at your current airspeed, given in minutes and seconds. For instance, "12:04" indicates twelve minutes and four seconds.

ADI MFD Page

The Attitude Director Indicator (ADI) page is an artificial horizon device to help the pilot fly under "black box" conditions (having to rely solely on instrumentation without the aid of an exterior view). It displays information about your airspeed, angle-of-attack, altitude, turn rate, heading, etc.

The functionality is identical to the physical ADI, and the electronic symbology is identical to the navigation symbology that appears on the HUD in NAV mode — see p. 2.16 for details.



Radar MFD Page

*For additional information, see **Combat: Using the Radar**, p. 4.12.*

The Radar MFD page displays radar contact information. When you are in NAV (navigation) or AA (air-to-air) master mode, your radar is in air-to-air mode by default, and air-to-air radar contact information is displayed in the Radar MFD page. When you are in AG (air-to-ground) master mode, your radar is in air-to-ground mode by default, and air-to-ground radar contact information is displayed in the Radar MFD page.

You can also change radar modes at any time by pressing R. (If you have radar lock on a target in one mode, you may lose it if you switch to another mode.)

R — Toggle air-to-air / air-to-ground radar modes

Shift R — Place radar on standby (it ceases to emit radar signals) This makes you "stealthier" (less visible to enemy RWRs)

Both air-to-air and air-to-ground radar modes have different submodes. Air-to-air radar submodes are Long Range Search, Track While Scan, Boresight, Air Combat, Single-Target Track and AA Cheat. Air-to-Ground radar submodes are Ground Moving Target, Map and AG Cheat modes.

The current submode appears in the MFD page, next to PB 16.

Q — Cycle through radar submodes (or click PB16)

See pp. 2.32 for information on the Radar MFD page in air-to-air mode.

See pp. 2.36 for information on the Radar MFD page in air-to ground mode.

Radar MFD Page: Air-to-Air Mode

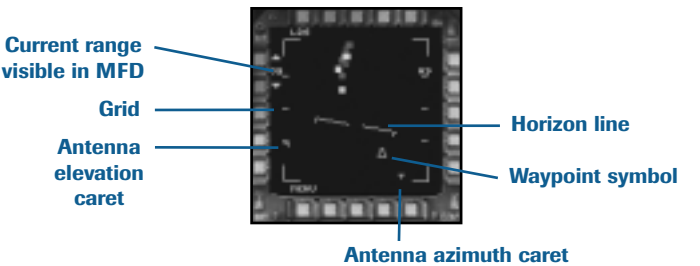
Your onboard radar has six different air-to-air search submodes, some of which activate automatically. Each has a specific use, and some are easier to use than others. If you don't want to rely on the radar for acquiring targets, select Air Combat Mode (ACM) and targeting occurs automatically.

This section only describes the symbology that displays in the Radar MFD when air-to-air radar is active. For specific information on how to use the air-to-air radar to target air threats, see **Combat: Using the Radar**, p. 4.12.

Q Cycle through air-to-air radar submodes (LRS / TWS / ACM). (Or press PB16 on the Radar MFD.)

Common Elements in Air-to-Air Submodes

Each Air-to-Air submode uses the common elements listed below.



Grid. Lines on the side of the Radar MFD divide the page into a 4 x 4 grid. The grid increment depends on the current visible range setting.

Current visible range. The AA Radar MFD is capable of displaying ranges from 5nm to 80nm (the LRS submode also has a 160nm range).

PBs 15/14 Increase/decrease visible range (5 / 10 / 20 / 40/ 80nm) (The LRS submode extends to 160nm)

Horizon line. This line simulates the horizon. When the aircraft is flying straight and level, the line is horizontal. The angle of the line changes when you bank, and it moves up and down when you change pitch.

Antenna azimuth and elevation carets. Two carets on the left and bottom sides of the Radar MFD represent the radar's current scan position. The bottom caret represents the horizontal scan (azimuth), while the left caret sweeps the vertical scan (elevation).

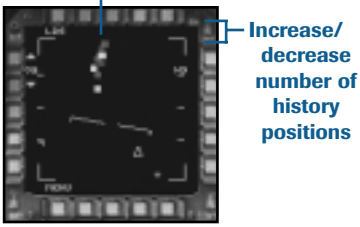
Waypoint symbol. The small triangle indicates the position of your current waypoint. Steer toward the symbol to get to the next waypoint.

Cursor. (Not shown) When you move the mouse cursor over the MFD, two vertical lines form a bracketed gate symbol and show your cursor position. You can move the cursor over a target and left-click on it to acquire a target.

Long Range Search (LRS) Submode

This mode lets you acquire targets at the longest range — 80 nautical miles. Of all the air radar modes, LRS provides the best detection capabilities, but it provides no initial information about targets other than their locations.

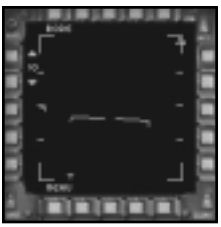
History. The scan refreshes the radar view every four seconds. By selecting a history setting, you can watch a target's progress over time. Each target's current position displays as a bright dot, along with up to three additional dim "history" dots showing its previous positions. Click PB1 to increase the number of previous positions to display, and PB2 to decrease the number of positions.



Boresight (BORE) Submode

This mode is a tool you can use to automatically acquire the first target in your immediate vision during close-range combat (under 10nm). To use Boresight mode, point your HUD at the target, and press and hold \. The target is automatically acquired. Release the key, and the radar enters STT mode. (See **Single-Target Track Submode**, p. 2.34.) If you have not acquired a target, the radar reenters its previous mode.

\ Activate boresight mode (press and hold).



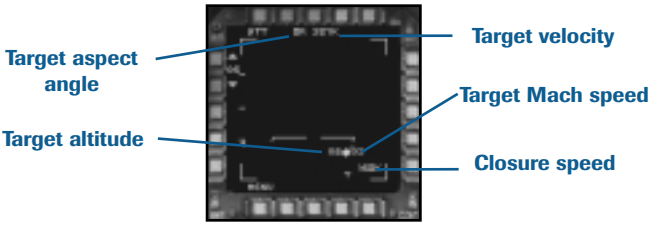
Air Combat (ACM) Submode

This mode is entirely automated and best used during short-range combat. The radar locks onto the first target entering its scan zone and auto-switches to STT mode. (See **Single-Target Track Submode**, p. 2.34.) As soon as you're in weapon range, you can fire.

No additional symbology appears for this mode.

Single Target Track (STT) Submode

This mode is automatically activated whenever you lock onto a target in LRS, TWS or ACM mode. It maintains a radar lock on a single target. STT mode displays the most target information of any mode, including the target's altitude (in thousands of feet), closure speed, and range.



Target altitude/Mach speed. The target's altitude in thousands of feet appears to the left of the target icon. The target's mach speed also appears (right number).

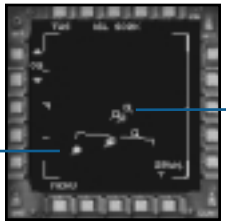
Target velocity. The target's current airspeed, in knots.

Target aspect angle. The angle of the target in relation to your aircraft's nose, in 10° increments. 2L, for instance, represents 20° to the left, while 3L represents 30° to the right.

Closure speed. How fast the target is flying toward or away from you. High, positive numbers mean you're closing in on the target, while low, negative numbers mean the target is slowly pulling away. This indicator slides up and down the DLZ, and the closure rate appears numerically next to it.

Track While Scan (TWS) Submode

This mode can track a priority target and still scan for other targets at a short range. It can track up to fifteen different targets simultaneously, displaying the position and direction of flight for each. Symbology is the same as in STT submode, with two exceptions.



Undesignated target icon. These small squares represent undesignated targets. The tail on each square represents the threat's current direction of flight.

Priority target icon. The first target the radar comes across in its scan is designated as the *priority target*. It has a star-shaped icon around it, and it is brighter than other targets in the Radar MFD. The altitude, velocity, aspect angle and closure speed for this priority target appear at all times as long the target remains in the Radar MFD page. You can designate a different priority target by left-clicking on an undesignated target icon or pressing Enter to cycle through targets.

View target altitude/mach speed
(move mouse over threat icon in MFD)

AA Cheat Submode

This mode is active only if you turn on ENABLE CHEAT RADAR in the *Preferences* window. Similar to the track-while-scan mode, it provides a 360° scan of the surrounding area. It also displays all air targets, regardless of their radar cross-signatures. Even stealthy F-117As appear on the Radar in this mode.

The symbology for AA Cheat mode is identical to the TWS symbology.

Radar MFD Page: Air-to-Ground Mode

For additional information, see ***Combat: Using the Radar****, p. 4.12.*

The radar defaults to AG mode whenever you switch to AG master mode ([M] cycles through master modes) or select an AG weapon ([ ]). Press [R] to manually toggle between air-to-air and air-to-ground radar modes.

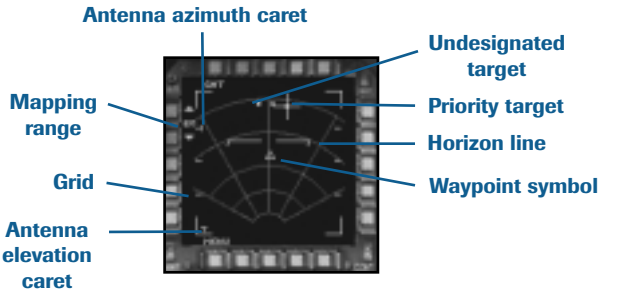
The air-to-ground radar has three submodes — MAP, GMT and AG CHEAT. The current radar submode (MAP OR GMT) appears in the upper left corner of the Radar MFD by PB16.

[Q] Cycle through air-to-ground radar submodes (MAP/ GMT / AG CHEAT) or press PB 16 on the Radar MFD.

This section only describes the symbology that appears in the Radar MFD when air-to-ground radar is active. For specific information on how to use the air-to-ground radar to target ground threats, see **Combat: Air-to-Ground Radar Submodes**, p. 4.20.

Common Elements in Air-to-Ground Submodes

All air-to-ground modes use the same symbology, detailed below.



Grid/map contour. The radar grid appears as a background. In Map mode, a terrain contour map also displays behind the grid and shows terrain features.

Mapping range. The Radar MFD is capable of displaying ranges from 10nm to 80nm. The current range appears on the Radar MFD.

[<] / [>] Increase/decrease visible range in Radar MFD (10 / 20 / 40 / 80nm) or PB 14/15

Antenna azimuth and elevation carets. Two carets on the left and bottom sides of the Radar MFD represent the radar's current scan position. The bottom caret represents the horizontal scan (azimuth), while the left caret sweeps the vertical scan (elevation).

Elevation azimuth caret. The caret on the bottom of the Radar MFD in ground mode represent the radar's current scan position. It represents the horizontal scan.

Undesignated targets. These small squares represent threats detected by your radar.

Priority target. When you left-click on a target, bright cross hairs appear over it and remain on the MFD display. You can designate a different priority target by left-clicking on another threat icon or pressing ENTER to cycle through targets.

If you're in GMT mode and double-click on a target, it becomes a GMTT target. This means the radar tracks its movement. A small line extending out from the target icon shows what direction the target is traveling.

Horizon line. This line simulates the horizon. When the aircraft is flying straight and level, the line is horizontal. The angle of the line changes when you bank, and it moves up and down when you change pitch.

Waypoint symbol. The small triangle indicates the position of your current waypoint. Steer toward the symbol to get to the next waypoint.

Cursor. (Not shown) When you move the mouse cursor over the MFD, two vertical lines form a cross hair and show your cursor position. You can move the cursor over a target and left-click on it to acquire a target.

Map Submode

This mode is the default air-to-ground radar mode and the best mode for targeting and striking stationary objects on the ground. You can adjust the map range and scroll across the map by using the pushbuttons.

No additional symbology is displayed in this mode, although a terrain map appears behind the grid.

Ground Moving Target Identification (GMT) Submode

This mode lets you spot moving ground targets, but not stationary ones. You can use it to track, acquire and attack targets on the ground or water.

No additional symbology is displayed in this mode.

AG Cheat Submode

The air-to-ground radar has a cheat mode you can enable by selecting ENABLE CHEAT RADAR from the *Preferences Window* . Instead of the usual 120° scan, it provides you a 360°-scan of the ground around you.

Functionally, AG Cheat operates similarly to GMT mode. The one exception is that *all* moving targets have tails indicating their direction of movement. Other targets appear as small squares with a hole in the center.

No additional symbology is displayed in this mode.

Radar Warning Receiver (RWR) MFD Page

For additional information, see ***Combat: Viewing Threats in the RWR****, p. 4.25.*

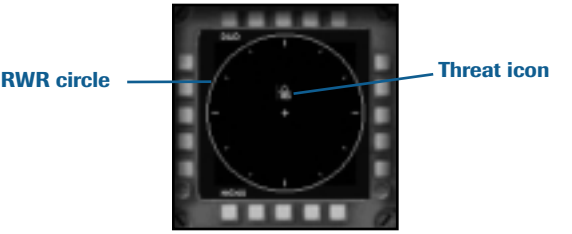
The RWR is a passive radar system that detects other objects' radar emissions. It is active at all times and can identify up to 10 separate threats up to 40nm away. It can also track radar-guided missiles launched against your aircraft.

U Display RWR MFD page

The RWR considers air threats that have launched missiles the most important, following by AAA fire, then SAMs that have launched missiles. If no missiles are airborne, priority is assigned to the nearest enemy aircraft / AAA site / SAM site (in that order).When another radar has locked onto your plane and fired heat- or radar-guided missiles, SAM missiles or AAA gunfire, its threat symbol appears in the RWR.

You receive an audio warning when a threat has locked onto your aircraft (one short beep) or fired a missile (siren and "Missile Launched!" message every five seconds).

Note: *In most aircraft, the RWR is an MFD page. However, some aircraft have a physical RWR in the cockpit dash.*



RWR circle. This circle represents detection range/area of the radar warning system — a 25nm radius, 360° around your aircraft. The RWR can detect any threats emitting active radar signals within this circle. The *cross* in the center represents your aircraft's current position. *Tic marks* around the perimeter represent 30° increments. The top of the circle is 0°, or straight in front of your aircraft's nose.

Threat icons. Shows the target category and type. Threats are marked with symbols (general target category) and number codes (specific target type). See **Combat: Viewing Threats in the RWR**, p. 4.25, for a full list of threat codes.

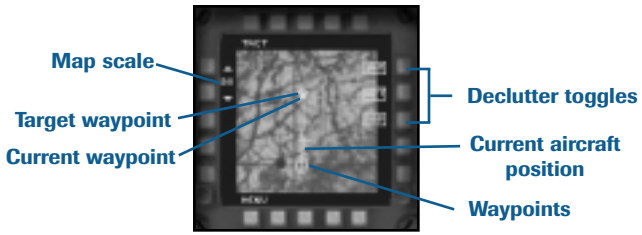
- Denotes aircraft (in this case, an F-16)
- Denotes SAM
- Denotes boat
- Denotes AAA sites
- Denotes Gundish icon

If a threat symbol is flashing, that threat has fired at you.

Tactical MFD Page

The Tactical MFD displays a geographical map of the immediate area, with tactical information laid on top of it.

T Display Tactical Map MFD



Current aircraft position. The small cross with a tail in the lower third of the MFD represents your aircraft's position. A circle appears around your aircraft and changes size depending on what map scale you have selected.

Map scale. You can zoom the map scale in and out by pressing the push-buttons. Available ranges are 10 / 20 / 40 and 80nm.

PB14 / PB15 Decrease/increase visible map range
(or Shift < / >)

SAM threats/circles. Surface-to-air missile sites show up as solid circles. A large circle surrounding the SAM threat icon represents the SAM's effective missile range. If you're trying to fly through a field of SAM circles, try to weave in between them to avoid coming into their range.

Waypoints. Navigation waypoints appear on the map:

Green line	Planned flight route
Hollow green circle	Normal waypoint
Solid green circle	Currently selected waypoint
Hollow red triangle	Target waypoint (with targets vital to mission success)
Solid red triangle	Current target waypoint

Declutter toggles. You can use PB1 — PB3 to toggle various elements of this display on or off. This is called *decluttering* because it simplifies the display.

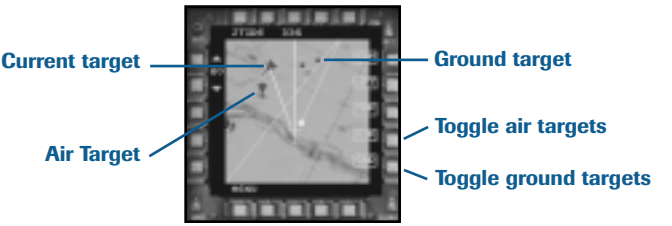
PB1 **(SAM)** Toggle known SAM sites, and their threat ranges.
PB2 **(WPT)** Toggle waypoints
PB3 **(MAP)** Toggle the rough topographical map

Joint Tactical Information Distribution System (JTIDS) MFD Page

When you fly the F-22A, F-117A, F-15C, F-15E or F-16C, the Tactical Map MFD is replaced by the Joint Tactical Information Distribution System (JTIDS) MFD. It's similar, but adds radar, RWR and AWACS/J-STARS data to the display. Additionally, the JTIDS is in full color. You can view the JTIDS in full-screen mode.

Z Display MFD in full-screen mode (press again to return)

When AWACS and JSTAR aircraft are in your area, additional targets appear on this screen. If you're flying in formation with other flights, their targets also appear on your radar.



The JTIDS symbology is similar to the Tactical MFD Page, with a few additions and changes:

Air targets. Aircraft appear as triangles pointing in the direction of flight. Enemies are red; friendlies are blue. If an aircraft is firing a missile, its icon flashes.

PB4 (AIR) Toggle air targets (visible/hidden)

Ground targets. The JTIDS shows all ground targets, not just SAMs. Stationary ground objects appear as squares; moving ground objects are squares with small lines pointing in the direction of movement. Enemies are red (specified enemy targets are solid red) ; friendlies are blue. If an object is firing a missile, its icon flashes.

PB5 (GND) Toggle ground targets (visible/hidden)

If a SAM has locked onto you, a small red kill radius circle appears around it. If the SAM has fired a missile, its icon and kill radius start flashing.

Current targets. If you lock onto an air or ground target, a yellow line connects your aircraft to that target, and target's icon turns solid yellow.

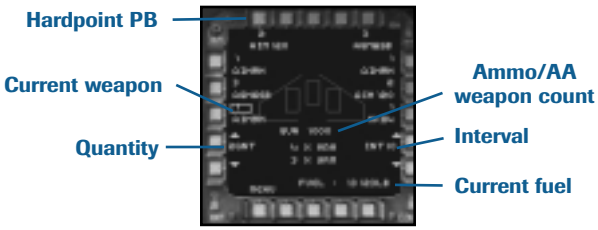
If another aircraft in your flight has a radar lock on a target, the line also appears, but it's dashed.

Stores Management System (Stores) MFD Page

*See **Using Weapons**, p. 4.28-4.50, to learn how to fire all types of weapons.*

When you select an air-to-ground weapon, the Stores MFD page automatically appears.

[ ] / [ ] Cycle through air-to-air / air-to-ground weapons (or, press hardpoint PBs on Stores MFD page)



Hardpoint PBs. The number and name of the weapon(s) loaded on each hardpoint appear next to these PBs. Click on a PB to arm (select) that weapon. If a green "X" appears on top of a hardpoint, that weapon has malfunctioned and remains unavailable for the rest of the mission.

PBs 1-3, 13-15, 16, 18 and 20 Click on a PB to select the weapon listed next to it.

Current weapon. The hardpoint label for the currently armed (selected) weapon is boxed. Press [ ] or [ ], or click a hardpoint PB to change weapons.

Ammo/AA weapon count. Lists number of rounds of gun ammo (GUN 240), short-range and medium-range missiles (4 X SRM and 2 X MRM, for instance).

Current fuel. How many pounds of fuel remain.

Quantity (QNT). (Bombs/rockets only) Number of weapons released in one salvo, initiated by a single weapon launch command. This is often called "ripple-firing." This setting defaults to 2, but ranges from one to however many bombs are left of that type.

PB11 / PB12 Increase / decrease the number of bombs in a salvo.

Interval (INT). (Bombs/rockets only) Delay between weapon releases during a ripple-fire release. Higher intervals spread your weapon impact points over a longer distance.

PB4 / PB5 Increase /decrease distance between weapons released in a salvo, by 10-meter intervals.

***Note:** Stealth aircraft (i.e., the F-22 or F-117) keep weapons hidden in bomb bays to reduce the aircraft's radar signature. The bay doors on these aircraft automatically open prior to dropping a bomb.*

FLIR (LANTIRN) MFD Page

*See **Combat: How to Drop Laser-Guided Missiles and Bombs**, p. 4.48, to learn how to use laser-guided weapons. For more information on FLIR technology, see **Combat: Forward-Looking Infrared**, p. 4.10.*

The AVQ-26 LANTIRN pod helps you fire laser-guided bombs or IIR missiles. It's automatically loaded onto all aircraft except the F-4E — you must manually load a LANTIRN pod on this aircraft.

The LANTIRN system contains an advanced Forward-Looking Infrared (FLIR) camera, which allows you to acquire targets and navigate under varying weather and light conditions. FLIR camera images are fed into the FLIR MFD page.

The LANTIRN is also used to laser designate targets and to track a laser designation provided by another friendly aircraft or ground object. In this context, The LANTIRN has two different modes — *active* (laser is on and lasing a target) and *passive* (laser is off and LANTIRN is tracking another mission element's laser designation).

Active vs. Passive LANTIRN Mode

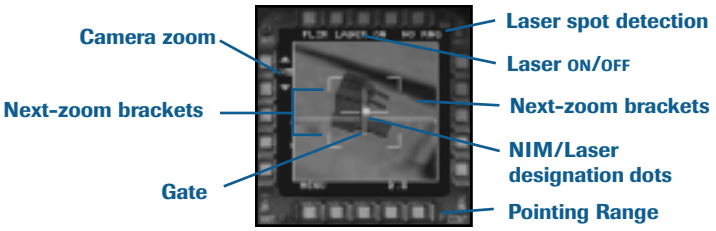
The AVQ-26 LANTIRN pod is active when the laser is on. This allows you to laser-designate and track targets in a cone measuring 80° left and right, 60° up, and 134° down. You can then drop laser-guided bombs, which home on the laser designation. You can manually pan the camera/laser from within this MFD to fine-tune the designation.

- Other aircraft in your sortie can view your designation by using the LANTIRN system in passive mode.
- If your air-to-ground radar has locked onto a target, the LANTIRN pod automatically acquires that target. (It always acquires the current radar target.)
- If you press Enter to switch radar targets while the LANTIRN is active, the LANTIRN automatically acquires the new target you picked.
- If your designated target moves out of range, the designation point moves to the edge of the MFD and remains there until you bring the target back into view or until the LANTIRN's camera can no longer track the target.

The LANTIRN is in passive mode when the laser is off. In passive mode, the LANTIRN pod locks onto a laser designation provided by friendly forces. If more than one designation exists, the pod locks onto the closest one. The LANTIRN can detect designations up to 25nm away.

- If you have a radar target locked, the LANTIRN automatically acquires that target by default (active mode only).
- The LANTIRN cannot lock onto high-contrast targets in passive mode.

FLIR/LANTIRN Symbology



Camera zoom. In active mode, you can manually pan the LANTIRN camera view and zoom it in and out. (Not available in passive mode.)

PB14 / PB15 Cycle through camera zoom levels (1X / 2X / 4X / 8X)

Ctrl + ←→↑↓ Pan the LANTIRN camera boresight.

Next-zoom brackets. Four L-shaped brackets marking the field of view for the next-largest zoom level. (These do not appear at 8X zoom.)

NIM/Laser designation dots. FLIR camera/laser position relative to its boresight (straight-ahead view). To establish a laser designation, center the NIM dot within the *gate* and on top of the *contrast lock*, then activate the laser.

Gate. Center of the LANTIRN's camera view, and the area under which the LANTIRN pod tries to acquire a contrast lock.

Contrast lock. (Not shown) The LANTIRN pod constantly scans underneath the gate for "hot" (high-contrast) targets. When the gate moves over a hot object, it automatically locks onto it. The FLIR camera view centers on this contrast lock, which is marked by a bright white square on HUD. Panning the camera breaks this lock.

Pointing range. Range to center of camera's current view. Max range in active mode is the AG radar's max range. Max range in passive mode is 25nm.

Laser ON/OFF. Text describing the current state of the laser. Turning the laser on puts you in active LANTIRN mode. Turing it off puts you in passive mode.

L or PB 18 Toggle laser on/off

Laser spot detection. When LANTIRN locks onto the nearest laser designation, IN RANGE appears here. NO RNG means you're out of range, UNCGD means you don't have a valid target.

Full-Screen View

You can also view this MFD in full-screen mode (highly recommended).

Z Display MFD in full-screen mode (press again to return)

Ctrl + ←→↑↓ Pan the LANTIRN camera boresight.

Horizon line. (Full-screen only) Current horizon position, relative to aircraft's attitude.

Current waypoint (Full-screen only) Currently selected waypoint, which appears as a numbered circle.

TV MFD Page

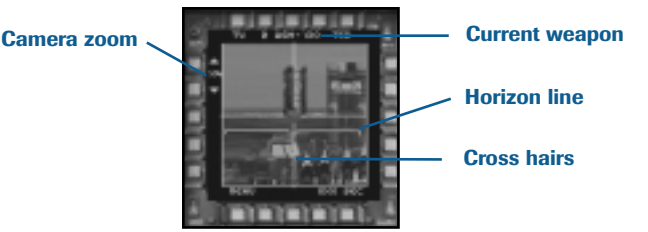
For step-by-step firing instructions, see ***Combat: How to Fire TV-Guided Missiles****, p. 4.44. Those instructions apply to TV Bombs as well.*

TV weapons are generally reserved for long-range, precision stand-off attacks. There are two types of TV-guided weapons: fire-and forget (AGM-65 Maverick) and steerable after launch (AGM-130, AGM-142 and GBU-15).

You can't access this MFD from the Menu MFD page — it automatically opens when you select a TV-guided missile or bomb. The TV camera's current position shows up in the HUD as a diamond, and the TV MFD shows a close-up image of its target.

If you are using a GPS-guided (JDAM) missile and you are flying an aircraft with at least 2 MFDs, the TV MFD page appears, with a FLIR image from the missile camera.

Basic TV MFD Symbology



Current weapon. Name of the selected weapon, and the number remaining on the currently selected hardpoint.

Camera zoom. You can manually zoom and pan the TV camera. If you pan the AGM-65 camera after launch, however, you will lose your target lock.

PB14 / PB15 Cycle through camera zoom levels (1x / 2x / 4x / 8x)

Ctrl + ←→↑↓ Pan the TV camera

Contrast lock. (Not shown) The TV camera scans its field of view for "hot" (high-contrast) targets. When the camera detects such an object, it displays a white rectangle in the MFD. The camera view centers on the contrast lock and marks the current target on the HUD with a white square. Panning the camera manually prior to launch breaks this lock.

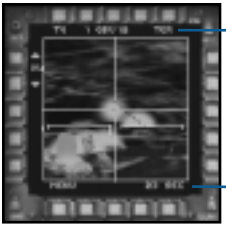
To manually slave the camera to a target, press Enter to acquire a radar target, or click on a target in the MFD.

Cross hairs. A vertical and horizontal line with a small gap at the point of intersection. The gap represents the lock location.

Horizon line. (Missile only) Current horizon position, relative to aircraft attitude.

Additional Symbology for Steerable Weapons

The symbology for this mode is similar, but not identical, to TV-Guided missile mode. The differences are noted below:



Flight stage. GBU-15s have two loft profiles after launch. The current stage, or profile, is represented in the MFD as transitional (TRAN) or terminal (TERM). Before launch, the flight stage is listed as ready (RDY).

TRAN The weapon automatically enters transitional loft profile after launch. During this stage, it maintains speed, loses altitude and gently corrects its heading while following the TV guidance system. You can control the yaw of the weapon (its heading) with Ctrl and ←→. You can control the weapon's pitch by panning the TV camera.

TERM Thirty seconds before impact, the weapon switches to terminal loft profile. The seeker head attempts to keep a steady bead on the target. You can use Ctrl and ←→↑↓ to make minor pitch and yaw adjustments up until impact.

- AGM-130s are in terminal mode from release until impact because they're equipped with a jet engine.

Estimated Time-to-Impact (ETI). How long it will take the bomb to reach its target and detonate. "20 SEC," for instance, means it will take 20 seconds to impact. If the ETI exceeds 300 seconds, "XXX" displays instead.

Full-Screen View

You can also view this MFD in full-screen mode (highly recommended). With full-screen mode active, you can pan the camera view.

+ / −	Zoom MFD in/out
Z	Display MFD in full-screen mode (press again to restore MFD view)
Ctrl + ←→↑↓	Pan camera view (full-screen view mode only)

Current waypoint (Not shown; full-screen only) Currently selected waypoint, which appears as a numbered circle. The target waypoint has a "T" in the circle.

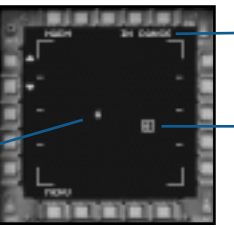
HARM MFD Page

For step-by-step firing instructions, see ***Combat: How to Fire Radar-Homing (HARM) Missiles****, p. 4.42.)*

The HARM Missile MFD auto-activates when you select a HARM missile. This MFD page aids you in aiming the AGM-45 Shrike and the AGM-88 anti-radiation missiles, most often employed against SAM sites. However, HARM weapons can attack any radar-emitting source within 30nm and within a 120° cone of view. These missiles are fire-and-forget, meaning you can't manually guide them after launch.

A HARM missile locks onto the first radar-using target it finds. If more than one target is spotted, it locks onto the nearest one.

Note that the display is oriented straight ahead (where your aircraft's nose is pointed). To see targets below you, pitch the nose down.



Cross hairs. A vertical and horizontal line with a small gap at the point of intersection. The gap represents the lock location. To place cross hairs on the MFD, double-left-click inside the MFD on top of the intended HARM target.

Threat icon. Each threat has its own numerical threat icon. The icon for the currently locked threat is boxed.

Threat Type	Icon	Threat Type	Icon
SA-2	2	*Hawk*	H
SA-3	3	*ZSU-23X4*	A
SA-5	5	*Patriot*	P
SA-6	6	*Roland*	R
SA-8	8	*General AAA*	A
SA-10	10		

Target status. Indicates the status of the currently locked target.

NO RANGE	Missile has a lock, but target is out of weapon's range
IN RANGE	Missile has a lock, and target is in range; ready to fire

Damage MFD Page

When your aircraft is hit with bullets or missiles, it takes damage. You can monitor the current status of your aircraft's systems in the Damage MFD. This MFD lists the most important systems on the plane and their current status.

When a system is damaged in combat, the master caution lamp lights up in the cockpit. You can left-click on it to turn it off and automatically display this screen.

[D] Display Damage MFD
(or click on master caution lamp)

In this MFD, you can left-click the pushbutton next to any system name to open that MFD. (See p. 2.29 for a listing of MFD names and page numbers for more information about a particular page.)

In general, GO indicates an operational system, and NOGO or MAL indicates a moderate to severe system failure. Below are specific damage messages.

ENG MAL	Engine on fire (use extinguisher within 10 seconds)
AB MAL	Partial afterburner failure (one is operable)
AB NOGO	Total afterburner failure (neither is operable)
GEAR NOGO	Gear is stuck either up/down; belly landing possible
GEAR MAL	Cannot land; must eject at end of mission ([E] x 3)
FLAP NOGO	Flaps will not raise/lower
ABRK NOGO	Air brakes will not extend/retract
WBRK NOGO	Wheel brakes will not engage
FLTC NOGO	Control surfaces inoperable; must eject ([E] x 3)
FLTC MAL	Ailerons, elevators or rudder damaged
ELCT NOGO	Instrument failure; no avionics, weapons, afterburner
ELCT MAL	Avionics failure; no radar, HUD, RWR, ILS, Nav info, ECMs
RDR NOGO	Radar inoperable
HUD NOGO	HUD modes inoperable; only partial HUD displays
INS NOGO	NAV computer inoperable; no nav data, ADI, HSI
NVG NOGO	NAV computer inoperable; no nav data
RWR NOGO	RWR inoperable; blank RWR screen
ILS NOGO	ILS inoperable; no landing cues
DASH NOGO	DASH system inoperable
ECM NOGO	Countermeasures inoperable; no chaff/flare
WPNS NOGO	All weapons inoperable
WPNS MAL	A/A, A/G weapons inoperable; gun is okay
GUN NOGO	Gun inoperable
RFLH NOGO	Refueling hatch inoperable; no refueling

COCKPIT VIEW CONTROLS

All aircraft in *Jane's USAF* are equipped with a useful and entertaining array of external camera views. The best flying in the world won't save you if you lose your tally because you can't locate your target.

These view controls let you pan around the cockpit, or jump into an external view. Take some time to become familiar with these keys, as they can often make a remarkable difference in the outcome of a fight.

Here are the most common views. For a complete listing, see the printed *Reference Card*.

F1 **Cockpit/HUD View.** Toggle view that displays either the physical cockpit or full-screen HUD view.

F2 **3D, Panning Cockpit View.** Pannable, 3D view of the inside of the cockpit. Pan around using Shift and the arrow keys, or use the hat on your joystick.

F3 **Padlock Target View.** Interior cockpit view that points your "eyes" directly at the currently locked target. Even if the target isn't in your HUD view, this view still looks in the direction of the target. Your "eyes" follow the current target up to 90° left/right.

F4 **Target View.** External view of your current target.

F5 **Player—Threat View.** External view of your aircraft that lines the camera up with your aircraft and the closest inbound missile.

F6 **Player — Wing View.** External view of your aircraft that lines the camera up with your wingman. Press this key multiple times to cycle through other aircraft in your flight.

F7 **Player — Target View.** External view of your aircraft that lines the camera up with the current target. Press again to reverse the view.

F8 **Arcade View**. External view of your current target that lines the camera up behind your aircraft in a "chase view."

F9 **Fly By View.** External view of your aircraft as it performs a fly-by. Press again to view the fly-by from a fixed point.

F10 **Chase View.** External view of your aircraft. Press this key multiple times to view close-ups of different parts of your aircraft. To pan while in this view, use the arrow keys or mouse.

F11 **Weapon View.** External view of your missile that lines up with the current target

F12 **Action View.** As F9, but shows fly-bys of target aircraft. Pressing the key multiple times cycles through various views of other target aircraft in the mission. (If you see only one plane in this view, fly a mission with more aircraft.)

3

FLIGHT

Previous page: A KC-10A boom operator's, or "boomer's", view of a refueling F-117A.
USAF photo by Senior Master Sgt. Rose Reynolds

Chapter 3

FLIGHT

This chapter contains the information you need for basic flight:

Basic Physics (p. 3.1) discusses the forces governing flight (such as thrust, lift, and gravity); the effects of altitude, angle-of-attack and airspeed; and G-forces.

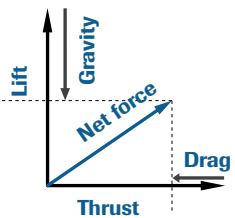
Flight Control (p. 3.8) provides an overview of basic aircraft control systems and explains how to use them.

Basic Flight (p. 3.10) covers taking off (p. 3.10); navigating to waypoints (p. 3.11); using the autopilot system for navigation, low-level flight and mid-air refueling (pp. 3.14-3.15); manual mid-air refueling (p. 3.16); using night vision goggles (p. 3.18) and landing (p. 3.19).

Flight Disruptions (p. 3.22) describes different types of stalls and spins while offering advice on avoiding and recovering from them.

BASIC PHYSICS

Flight is the result of several forces acting upon an aircraft. The first is the aircraft's *weight*, or the gravitational force pulling it toward the ground. The second is *thrust*, the force produced by the engines propelling the plane through the air. This forward movement causes air to move over the wings, which in turn creates a *lift* force which counteracts the gravitational force. The final force acting on an aircraft is *drag*, generated as the aircraft moves through the air, pushing against the aircraft in a direction opposite to its movement.



Each of these component forces (weight, thrust, lift, and drag) has a direction and quantity. The overall effect of these forces, called the *net* or *resultant* force, determines how the aircraft flies.

Thrust

An aircraft's engines generate a thrust force. As this thrust force propels the aircraft forward, air moves over and under the wings, generating a lift force. Thus, the amount of thrust the engines generate governs not only how fast the aircraft moves forward, but also how much lift it can generate.

A common measure of an aircraft's power is its *thrust-to-weight* ratio. This is the ratio between its total weight (including airframe, equipment, crew, and stores) and the thrust capability of its engine. A ratio greater than 1:1 indicates an aircraft can overcome gravity in a vertical climb.

The table below compares the flyable aircraft, their engines, and maximum thrust ratings. Thrust ratings listed are for dry operation (i.e., without afterburning) and are given in static pounds of thrust (lb st). All statistics are courtesy of Jane's Information Group, Ltd. See **Aircraft Specifications**, p. 7.1.

	ENGINES			Thrust	Total
	#	Make	Model	(lb st)	(lb st)
A-10A	2	General Electric	TF34-GE-100	9,065	18,130
F-117A	2	General Electric	F404-GE-F1D2	21,600	21,600
MiG-29	2	Klimov/Sarkisov	RD-33	11,100	22,200
F-4E	2	General Electric	J79-GE-17	17,900	35,800
F-15C	2	Pratt & Whitney	F100-PW-220	23,700	47,400
F-16C	1	Pratt & Whitney	F100-PW-229	29,100	29,100
		or General Electric	F110-GE-129	29,588	29,588
F-105D	1	General Electric	J75-P-19W	26,500	26,500
F-15E	2	Pratt & Whitney	F100-PW-229	29,100	58,200

Airspeed

The pressure of air flowing around an aircraft can be used to determine its airspeed. As the speed of this airflow increases, so does its pressure; these variations in pressure are measured by a pitot tube mounted on the aircraft's nose and used to calculate airspeed. However, air pressure also varies with altitude and wind conditions. Thus, the computed airspeed of an aircraft flying at 30,000ft above sea level (ASL) with a constant thrust and angle of attack (AoA), is much slower than the computed airspeed for the same aircraft travelling under the same thrust and AoA conditions at a 5000ft ASL.

Airspeed Indicator. If you're using the AA HUD, you'll see indicated airspeed. If you're using the AG HUD, true airspeed is reported instead. The NAV HUD displays ground speed.

Three types of velocities appear in the game — one for each main HUD:

True airspeed. (AG HUD). Airspeed compared to air flowing around the aircraft.

Indicated airspeed. (AA HUD). Airspeed corrected to account for variations in air density and altitude; it gives the best indication of your aircraft's lift.

Ground speed. (AG HUD). Airspeed relevant to the ground (measured as "0" if you're going straight up or straight down).

Drag

Drag forces are created by the friction of air moving along the aircraft's wings and buildups of pressure as air pushes against the aircraft's surfaces. Drag forces cause an aircraft to resist movement in the direction of flight, thus reducing airspeed.

Induced drag is the rearward component of lift. As the wings produce more lift, they also produce more drag (thus a climbing aircraft requires increasing throttle to maintain a steady speed). As an aircraft approaches Mach 1, more pressure is created in front of the aircraft's wing than behind it, which creates a backward drag force known as *wave drag*. *Parasitic drag* includes wind resistance and all other types of drag not lift-induced. Different flight attitudes, speeds, and altitudes yield differing types and amount of drag.

Lift

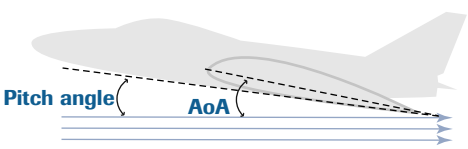
Lift is produced when air rushes over an aircraft's wing. As the wing meets the air, it separates at the *point of impact* and flows both over and under the exterior surfaces. Most aircraft wings are designed so the top surface is more curved, and thus longer, than the bottom surface. Because the air flowing *over* the wing travels farther than the air flowing *under* it, the airflow over the wing is faster.

This faster airflow over the top surface results in a low-pressure area immediately above the wing. The *pressure differential*, or imbalance of pressure, between the air above and beneath the wing results in a net force that pushes upward, causing lift.

Angle of Attack

The amount of lift produced by the wing varies according to the angle at which the wing hits the air. This angle is called the *angle of attack* (AoA). Generally, as angle of attack increases, lift increases — up to a point. If the wings hit the air at too great an angle, the air rushing against the wing pushes the aircraft backward more than upward. This reduces lift and forward velocity, which further reduces lift. Continued high-angle attack flight can in this way generate a stall.

Note: *If AoA is too high, an audio tone will activate in the cockpit, warning of an impending stall. See* ***Stalls****, p. 3.22, for more information.*



Angle of attack and an aircraft's *attitude* are closely related, although not the same. An aircraft's attitude is the pitch angle of its nose relative to the horizon. Your current AoA is not exactly the same as your pitch angle, because an aircraft's wings are not always level with the fuselage and they may bend somewhat during flight. However, as your pitch angle increases or decreases, so does your AoA.

Pitch ladder. Attitude is represented on the HUD by the pitch ladder — each bar indicates 5° of pitch. The ends of the bars point down if pitch is positive and up if pitch is negative (see **Cockpit: Pitch Ladder**, p. 2.15).

AoA and Airspeed

The AoA of an aircraft's wings greatly affects airspeed. If you're trying to fly level, it's important to remember you must accompany any change in AoA (i.e., any change in pitch) with a change in airspeed. At very low speeds (i.e., during takeoffs and landings), the relationship between pitch and airspeed is most pronounced.

You can find instructions for **Taking Off** (p. 3.10) and **Landing** (p. 3.19) in the **Basic Flight Maneuvers** section later in this chapter. Those sections walk you through pitch and altitude adjustments during low-speed flight conditions.

Altitude

An aircraft gains altitude as a result of lift. Altitude can be measured in two ways: distance *above ground level* (AGL) and distance *above sea level* (ASL). Altitude above sea level (ASL) is also known as *barometric altitude*.

Altitude indicator. Your altitude is reported on the right side of your HUD. If you're using the air-to-air master mode, altitude is given as ASL. If you're using the air-to-ground mode, however, altitude is reported as AGL. (See **Cockpit: Altitude Ladder**, 2.14.)

Because engine performance decreases as the air thins, changes in your barometric altitude affect your aircraft's performance capabilities. At 25,000 feet ASL, an aircraft's jet engines are only producing about half the power they can at sea level. Performance at high altitudes varies depending on an aircraft's engine power and design. The A-10A, for example, was designed as a durable, low-level CAS aircraft. Its engines were designed for stability at low speeds, and high-altitude performance was sacrificed to achieve this. On the other hand, fighters such as the F-15E and MiG-29 were designed with high-altitude air combat performance in mind.

The table to the right lists service ceilings for the eight flyable aircraft, where available. An aircraft's *service ceiling* is the ASL altitude at which its climb performance has dropped to a maximum of 100ft/min — in other words, down to bare minimum.

Statistics are from Jane's Information Group, Ltd., except where indicated. See **Aircraft Specifications**, p. 7.1, for more Jane's information on these aircraft.

Aircraft	Service Ceiling
F-15C	60,000 ft
F-16C	50,000 ft
MiG-29	55,775 ft
F-22A	50,000 ft
F-4E	28,100 ft
A-10A	44,200 ft**
F-15E	65,000 ft**
F-105D	51,000 ft**
F-117A	45,000 ft**

**Statistics from the USAF Museum's Archives Gallery web site (www.wpafb.af.mil/museum/research/rsrch.htm).

Turn Performance

An aircraft's maneuverability is determined by its *turn performance,* or its ability to change direction during flight. A fighter does not always need to be powerful in order to be maneuverable. The Vietnam-era MiG-17, for example, was by far one of the less powerful fighters in the skies over Vietnam. However, its turn performance exceeded that of at least one rival, the F-4E. In a series of skilled maneuvers, a capable pilot might press this advantage into an opportunity to get on his opponent's six.

This section explains the physics principles behind turn performance. See **Combat: Pursuit Curves** (p. 4.58) for instruction on capitalizing on turn performance advantages and minimizing disadvantages.

Load Factors and G-Forces

The relationship between the forces of lift and weight can be described in terms of "G." An airplane in level flight experiences 1G of force — 1G is equivalent to the gravitational force on an object at sea level. Making a turn increases the aircraft's acceleration and adds G-force — this is called the *load factor* of the turn. The higher the airspeed, the greater the load factor during a turn. Other accelerations — such as those produced by sharp climbing maneuvers or increased throttle also contribute to G-forces.

G-forces can be positive or negative. Positive Gs during a turn push you back into the seat, while negative Gs exert a pulling effect. In high-G maneuvers, your heart must work harder to pump blood away from the direction of the pull.

G indicator. Your current G level is reported on the bottom left of your HUD (+1.0G here).

Pilot Tolerance

A well-trained pilot can endure about 9-10 positive Gs for a limited time — anything beyond this can cause tunnel vision or blackout. Blood collects in the lower torso and the legs, denying blood to the brain. Eyesight starts to "gray-out," and eventually you will black out. A similar condition called "red-out" occurs when the aircraft pulls too many negative Gs — blood collects in the upper regions of the body, and the blood vessels in the eyes swell. This causes your vision to go red. Usually, this starts occurring after several seconds of flying at -3Gs or greater.

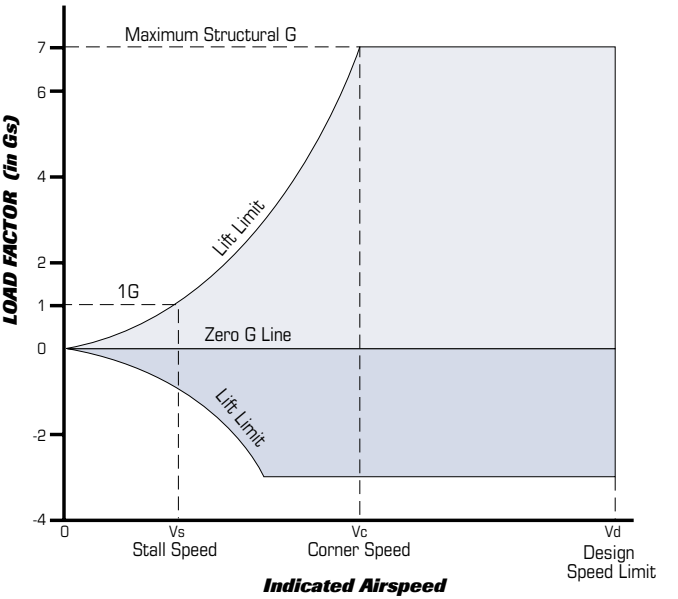
Both red-out and black-out effects are accurately simulated in the game — the screen will go red or black, and you may begin to have difficulty controlling your aircraft.

Instantaneous Turn Capability

An aircraft's instantaneous turn capability is its best turn performance at any given instant in time. The amount of lift an aircraft can produce relates directly to its instantaneous turn capability. Thus, when an aircraft's speed and altitude change, its instantaneous turn performance changes as well.

The *V_n diagram* below is a graphical representation of the relationship between airspeed and load factor. Above the **0G line** in the diagram, the aircraft is pulling positive Gs; below it, the aircraft is pulling negative Gs. The **maximum structural G limit** marks the maximum G-load the airframe can withstand. The **speed limit (V_d)** marks the aircraft's maximum attainable speed. The **lift limit** curves indicate the speed and load factor conditions where the aircraft is able to maintain enough lift to maintain altitude.

Stall speed (V_s) is the speed below which the aircraft wings cannot generate enough lift in level (1G) flight to keep the aircraft in the air.



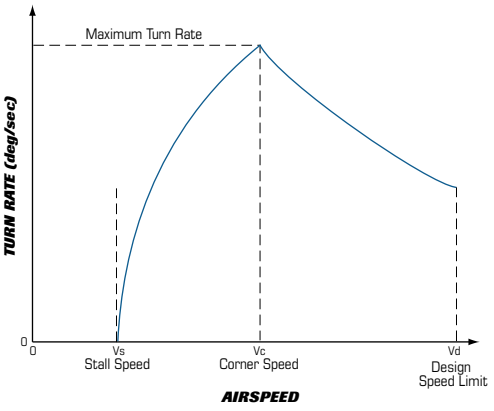
Corner Speed (Vc)

For any given altitude, the speed at which maximum lift occurs during a turn (without causing structural damage to the aircraft) is known as the *corner speed*. It is marked on the diagram above by the **corner speed (V_c)** line. At corner speed, the aircraft achieves its maximum instantaneous turn performance at a given altitude. In other words, it achieves the highest possible turn rate with the lowest possible turn radius.

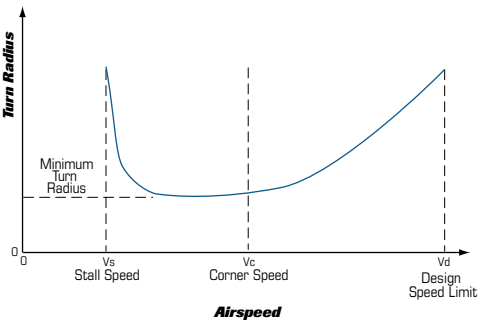
Turn Rate and Turn Radius

Turn performance is measured in terms of turn rate and turn radius. A high turn rate and a low turn radius yield the best turn performance.

Turn rate is the number of degrees per second a particular aircraft can turn. The higher its turn rate, the more quickly it turns. As the diagram to the right shows, turn rate increases with airspeed until the airspeed reaches corner speed (V_C). Beyond corner speed, turn rate begins to decrease as speed increases.



Turn radius is the radial distance an aircraft requires to complete a turn. The smaller its turn radius, the more tightly it turns. As the diagram to the right indicates, turn radius decreases shortly before an aircraft reaches its corner speed, then plateaus for a bit, then increases as the aircraft's speed increases beyond corner speed.



Sustained Turn Capability

In a sustained turn, the aircraft maintains a specific turn rate and radius for some time. The load factor must be at least 1G in order for the aircraft to maintain lift and altitude. At higher load factors, turn performance improves, but drag increases, decreasing lift. The overall sustained turn capability of an aircraft depends on its thrust-to-weight ratio and its lift capability.

Lower airspeeds yield optimal sustained turns — in general, the slower your airspeed (to a point), the more quickly you can execute a turn. This gives credence to the old fighter pilots' adage "Slow down and get there faster."

FLIGHT CONTROLS

Aircraft maneuver in three dimensions: *pitch, roll,* and *yaw*. These dimensions are always referenced from the pilot's point of view, regardless of the aircraft's orientation or flight attitude. This section describes main aircraft flight controls and explains how to use them to alter the aircraft's flight attitude.

Note: *In Jane's USAF, you can control flight using game controls (such as a joystick, throttle device and rudder pedals), the keyboard, or a combination of both. In this section, instructions for using game controls and the keyboard are both given. Keyboard commands are re-mappable, the keys listed here are default assignments. You can set up keyboard and game controls using the Preferences window (see* ***Appendix D: Preferences Window****, p. 8.8).*

Coupled Motion

Non-coupled motion, or motion along a single axis, can be generated by a single flight control input — such as yawing left with the rudder. More often than not, you will need to coordinate input from several flight controls to get the aircraft to move in the direction you want to travel. *Coupled motion*, or motion occurring along more than one axis requires coordinated inputs: yawing with the rudder and pulling the stick to pitch upward creates a banking turn or rolling effect, for example.

Flight Stick — Pitch Control

Moving the stick forward and backward moves the aircraft's elevators and flaps. Flaps and elevators move up and down in tandem, changing the lift over both wings equally, which causes a change in the aircraft's pitch. Pitch is the up and down movement of the aircraft's nose.

- Pull the stick back to lift the aircraft's nose upward. Pitching the nose upward and increasing throttle generally causes an aircraft to climb.
- Push the stick forward to drop the aircraft's nose downward. Pitching the nose downward generally causes an aircraft to dive.

[↑] Pitch nose downward [↓] Pitch upward

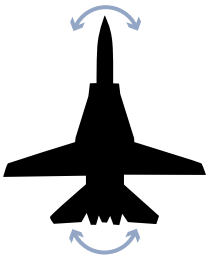
Flight Stick — Roll Control

Moving the stick right and left controls the ailerons. Ailerons, like flaps, are hinged panels on an aircraft's wings. Unlike flaps, however, ailerons move in opposite directions of one another. The result is lift increases on one wing and decreases on the other. This lift differential tilts the wings and rolls the airplane. Roll is movement around the aircraft's nose-to-tail axis.

- Pull the stick to the left to drop your left wing and roll to the left.
- Pull the stick to the right to drop your right wing and roll to the right.

[←] Roll left [→] Roll right

Rudder Pedals — Yaw Control



Pushing the rudder pedals moves the aircraft's rudder(s). Applying right rudder yaws the aircraft's nose right. Pushing the left rudder yaws the aircraft's nose left. Yaw is the right to left movement of the aircraft's nose.

Rudders are primarily used for lining up shots and spin recovery. Rudder can also induce a roll. When using rudder, most aircraft will roll in the direction that rudder is applied. The amount of roll varies with aircraft type.

- Push the left rudder pedal to yaw left.
- Push the right rudder pedal to yaw right.

Numpad [0] Apply left rudder Numpad [.] Apply right rudder

Throttle

The throttle controls the engine's output. Pulling the throttle back closes the throttle, decreasing engine output. Rapidly closing the throttle is called *cutting* or *chopping* the throttle. Pushing the throttle forward opens the throttle and increases engine output. The engine's maximum output without using afterburner is called *full military power*.

Afterburner increases engine thrust by dumping fuel into the engine's exhaust and igniting it. It provides a significant thrust increase over full military power, but consumes fuel four times faster than full military power. Afterburner provides a powerful boost, but must be reserved for critical situations. Use it to pull out of a stall or to catch up with (or outrun) an enemy.

In *Jane's USAF*, you can control how much fuel is being dumped into the afterburner. At level 2, the maximum amount of fuel is used for maximum boost. At level 1, less fuel is used for less of a boost.

- Pull back on the throttle device (or throttle wheel on joystick) to decrease thrust.
- Pull throttle (or throttle wheel on joystick) all the way back to decrease thrust to idle.
- Push forward on the throttle device (or throttle wheel on joystick) to increase thrust.
- Push the throttle device (or throttle wheel on joystick) almost all the way forward to increase thrust to full military power.
- Push throttle (or throttle wheel on joystick) all the way forward to ignite afterburner.

[1] Set thrust to 60% [2] Set thrust to idle (65%)
[3] Set thrust to 70% [4] Set thrust to 80%
[5] Set thrust to 90% [6] Toggle full military power (100%) on/off
[7] Afterburner, level 1 (AB1) [8] Afterburner, level 2 (AB2)
[9] Decrease throttle 5% [0] Increase throttle 5%

BASIC FLIGHT

This section explains the basic skills you will need to take off, steer through your waypoints, land, use night vision aids and refuel in mid-air.

Note: *Keyboards are re-mappable in Jane's USAF. Key commands listed are defaults.*

Taking Off

This section provides basic instructions for takeoff, and is designed as a reference guide. However, learning to fly — and in particular learning to take off and land — requires training and practice in the cockpit.

Takeoff Training Mission

Check out the Takeoff exercise of the Basic Training series. The instructor will walk you through the takeoff, step-by-step. To access this mission, select **TRAINING** from the Main Menu screen. When the Training screen appears, click **BASIC TRAINING** in the upper right corner of the screen, and then click **TAKEOFF**. Click on the plane you want to practice in, then click **LOAD**.

Basic Take Off Sequence

1. If you are not already on the runway, taxi out onto it. Follow the yellow signs pointing to the runway.
   - [B] Release your wheel brakes
   - [1] Increase throttle to 60% thrust

   Num [0]/[.] Steer left/right (or use rudder pedals)

2. Verify flaps are extended. A FLAPS indicator light should be lit somewhere on your instrument panel (placement varies by cockpit).
   - [F] Extend your flaps if they are not already extended.

3. Begin takeoff run. First, make sure you get a "Clear to Hold Runway" message from the tower. If the runway is not clear, the tower will request you to "hold short" on the runway.
   - [B] Re-engage wheel brakes
   - [8] Open throttle to afterburner 1
     (if using throttle device, push it almost all the way forward)
   - [B] Disengage wheel brakes

4. When you see the nose of your aircraft rise up slightly — at about 150 knots — pull up by pressing [↓] or pulling back on your joystick.
   - [↓] Pitch nose upward (if using joystick, pull backward)

5. When you reach an altitude of 300 AGL, retract your landing gear and flaps. Above Ground Level (AGL) altitude is reported on the box on the right side of your HUD (See HUD diagram, facing page.)
   - [G]/[F] Retract your landing gear / flaps

Navigation

This section serves as a reference guide to navigation in *Jane's USAF*. It familiarizes you with the basic systems and instruments providing navigational information and walks you through a typical navigation sequence.

Step Down Training Mission

There is no substitute for practice in the cockpit — in the **Step Down** exercise of the Basic Training series, the instructor will walk you through the basics of navigation, using the autopilot and low-level flight. To access this mission, select **TRAINING** from the *Main Menu* screen. When the *Training* screen appears, click **BASIC TRAINING** in the upper right corner of the screen, and then click **STEP DOWN TRAINING**. Click on the plane you want to practice in, then click **LOAD**.

Overview of Instruments

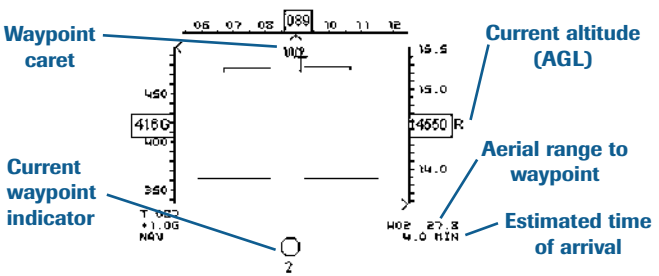
Navigation information is reported on your HUD, and on the INS and the Tactical Map or JTIDS MFD pages. These instruments and an overview of their features are presented in the following sections.

HUD in NAV Mode

Whenever the HUD is in NAV mode, it displays symbols that guide you to your next waypoint. These symbols include a *waypoint caret*, which scrolls across the heading bar, indicating the heading to your waypoint, and a *current waypoint indicator*, a circle on the HUD showing where the waypoint is located. The target waypoint appears as a triangle with a "T" next to it. The *aerial range to your waypoint* and *estimated time of arrival* (ETA) are displayed in the lower right alphanumeric field.

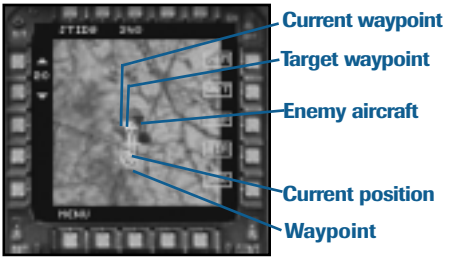
[N] Switch HUD to NAV mode.
(NAV appears in the lower left corner of the HUD.)

For more information on the HUD in NAV mode, see **Cockpit: Nav HUD Information**, p. 2.16.



Tactical/JTIDS MFD Pages

The Tactical Map page superimposes waypoint information over a scalable moving map of the area you are currently flying over. *Waypoints* are indicated by hollow circles; the *current waypoint* circle is solid. Target waypoints, i.e., waypoints where mission objective targets are located, are marked by hollow triangles; a current target waypoint is solid. The Tactical Map can also display known targets, threat and SAM threat circles, giving you an idea of their position with relation to your flight path.



In the F-117A, F-22A, F-15C, F-16C and F-15E, the Tactical Map MFD page is replaced by the Joint Tactical Information Distribution System (JTIDS) MFD page. This system can mark the position of air and ground objects picked up by nearby AWACS, JSTARS or Ground Control radar systems, as well as any target picked up by your flight's radar systems and your RWR.

To open the Tactical Map or JTIDS pages:

1. Click the **MENU** button on the MFD to call up the MFD main menu.
2. Click the **TACTICAL** or **JTIDS** button on the MFD.

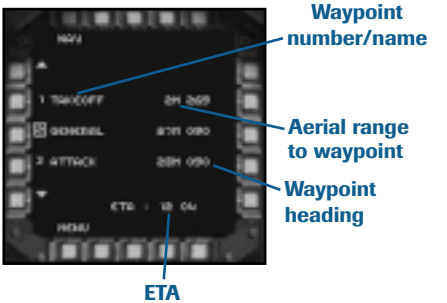
   — OR —

1. Press [T].

See **Cockpit: JTIDS MFD Page**, p. 2.40, or **Tactical MFD Page**, p 2.39.

NAV MFD Page

The Inertial Navigation System (INS) gives you data on your NAV MFD. It gives the current location and the location and direction of waypoints plotted along your route. It lists all waypoints, including waypoint *number*, *name*, *aerial range to waypoint* and *waypoint heading*. Click the arrow buttons to scroll through the list. Your estimated time of arrival (ETA) at your current waypoint is listed at the bottom left.



To open the NAV MFD page:

1. Click the **MENU** button on the MFD to call up the MFD main menu., then click the **NAV** button. (Or, press [N].)

For details, see **Cockpit: NAV MFD Page**, p. 2.30.

Navigating Through Waypoints

Waypoints are a series of coordinates along your flight path that help you navigate from your take-off point to the target area and then back to your landing site. Your "current" waypoint is the waypoint you are enroute to.

Choosing a Waypoint

When you pass within .5 miles of your current waypoint, the ILS auto-selects your next waypoint. If the waypoint is a target waypoint, however, it won't change — that way, you can fly around the target area.

You can also manually change your current waypoint. This may be useful if you need to bypass a waypoint to avoid enemy fire enroute to your target waypoint, for example.

W	Cycle through waypoints in numerical order
Shift W	Cycle backward through waypoints

Steering to a Waypoint

Normally, you will use the waypoint caret on the HUD heading tape to orient yourself toward your current waypoint.

- Find the waypoint caret on your HUD, and steer to place it in the middle of the heading tape.
- If the caret is all the way to one side of the heading tape, then the heading to your waypoint is outside the range of the bar. Steer in the direction of the caret until it begins to move toward the center of the tape.
- When the caret is near the center of the bar, only make very slight steering adjustments to center it. It is very easy to overcompensate.

Time Compression

If you want to speed up flight to your next waypoint, activate time compression. As you cycle through the settings, the current setting appears in the upper right corner of the screen.

C	Cycle through time compression (2x, 4x, 1x)
Ctrl C	Reset time compression to normal

Autopilot

The autopilot system can take over navigational flight while you are doing other things, to assist in in-flight refueling, and to maintain current above ground level altitude and heading for low-level flight.

Step Down Training Mission

In the **Step Down** exercise of the Basic Training series, the instructor will show you how to use the autopilot for navigation and low-level flight. To access this mission, select **TRAINING** from the *Main Menu* screen. When the *Training* screen appears, click **BASIC** in the upper right corner of the screen, and then click **STEP DOWN TRAINING**. Click on the plane you want to practice in, then click **LOAD**.

When autopilot is engaged, the autopilot indicator light is lit (its placement in the cockpit varies, depending on the aircraft), and the autopilot mode is indicated in the left alphanumeric field on the HUD. If you roll the aircraft more than 10° or pitch more than 5° while the autopilot is engaged, it automatically disengages.

[A] Cycle through autopilot settings (AP LVL, AP NAV or AP RFL, off)

AP LVL. Autopilot level: the AP maintains current heading and AGL altitude.

AP NAV. Autopilot navigation: the AP flies through waypoints.

AP RFL. Autopilot refuel: if the fuel hatch is open, the AP NAV automatically flies to the nearest refueling point. AP RFL appears on the HUD in place of AP NAV.

Using Autopilot for Low-Level Flight

Flying at low altitudes is the best way to remain undetected. Flying below 500ft puts you beneath the minimum detection altitude for most ground radar systems. Flying nap-of-the-earth (NOE), or hugging terrain contours, decreases your chances of being detected by airborne radar systems by making it difficult for them to pinpoint and track your location among the "ground clutter."

Low-level flight is extremely difficult for fixed-wing aircraft flying slowly. The autopilot in AP LVL (autopilot level) mode can be used for NOE flight. Under 500 feet, it switches to AGL and tries to maintain altitude *above ground level* so that you won't crash — however, it's not foolproof.

Use this tactic with caution, and only over ground that's relatively flat.

To use the autopilot for low-level flight:

1. Orient your aircraft toward your waypoint and drop down to the altitude you wish to maintain.
3. Press [A] to cycle through autopilot settings until AP LVL appears in the lower left corner of the HUD.

The autopilot maintains the heading and AGL altitude. To disengage, pitch the aircraft upward more than 5° or press [A] to cycle through autopilot settings until they vanish from the HUD, indicating that the autopilot is off.

Using Autopilot for Mid-Air Refueling

For longer missions, you may need to refuel in-flight. Manual mid-air refueling requires precise control, patience and much practice. If you are short on any of these, you may want to turn control over to the autopilot.

To refuel on autopilot:

1. Open your refueling hatch and request a vector to the nearest tanker. READY will appear on the left side of the HUD, indicating the boom hatch is open and functional. The rest of the pilots in your flight will likewise prepare to refuel.

   Ctrl R Open refueling hatch and send radio request for vector to tanker. As flight leader, you will refuel first.

2. The controller gives you heading and range to the nearest tanker. He or she updates this information until you are within 2 miles of the tanker. Engage the autopilot in AP RFL mode to fly to the tanker on autopilot.

   A Cycle through autopilot settings until AP RFL appears in the lower left corner of the HUD.

3. When you are within one mile of the tanker, its pilot radios permission to join. The autopilot aligns you with the tanker, connects and maintains position while the fuel is transferred.

   As you are positioning, your flight will align in refuel formation on the tanker, with each aircraft 45° back and to the *right* of the one in front of it, maintaining a 900ft spread. (See diagram on p. 3.17.)

4. After fuel is transferred, the tanker pilot radios: "Full, clear to disconnect." Reduce throttle to idle and maintain a very steady hand on the flight stick. If you fail to reduce throttle enough, or move the stick too far in any direction, you risk a hatch malfunction.

   1 Reduce throttle to idle (if you are using a throttle device, pull it almost all the way closed)

5. Reducing to idle thrust slows your aircraft, allowing it to drop away from the boom. When you are clear of the tanker, bank away to the left. Once you are 300ft from the tanker, its pilot radios your wingman to begin lining up.

6. Remain within three miles of the tanker while the rest of your flight refuels. As each aircraft refuels, it returns to formation on your tail, with each aircraft 45° back and to the *left* of the one in front of it, maintaining a 900ft spread. (See diagram on p. 3.18.)

7. After all aircraft are clear of the tanker, fly out of the three-mile radius. Your flight will return to standard cruise formation.

   When you leave the radius, other aircraft in your sortie leave at the same time, whether or not they've finished refueling. If an aircraft doesn't complete the refueling process, that plane leaves with a partially full tank.

Manual Mid-Air Refueling

You can also choose to manually execute mid-air refueling, but again this requires a great deal of practice. It requires you to drop behind another aircraft and line the end of a relatively small boom up with a hatch opening that you cannot see.

The sequence below outlines the procedure — familiarize yourself with this, then perhaps sit through a few mid-air refuelings on autopilot to get a feel for how things should look, then check out the Air Refueling training mission.

Air Refueling Mission

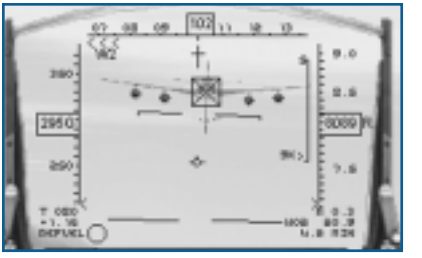
Next to landing on an aircraft carrier, mid-air refueling is perhaps the most difficult task a military pilot is routinely asked to execute. To access the mid-air refueling exercise, select **TRAINING** from the *Main Menu* screen. When the *Training* screen appears, click **BASIC** in the upper right corner of the screen, and then click **AIR REFUELING**. Click on the plane you want to practice in, then click **LOAD**.

Overview of Instruments

In addition to all of the flight symbology you normally use when in NAV HUD mode, you also need to visually monitor the following new information.

Refuel status. Once you open your fuel hatch, the boom operator sends audio cues to report the status of the refueling process.

Tanker direction system. This system consists of audio cues from the boom operator to direct the refueling plane into position. He'll broadcast messages that appear at the top of your HUD — for example, "Left" and "Up."



Basic Mid-Air Refueling Sequence

Note: *Steering becomes half as sensitive during refueling to allow for a light touch. You'll need to move the joystick twice as far as normal to move the aircraft.*

1. Open the refueling hatch and radio a request for a vector to the nearest tanker. All other aircraft in your flight do likewise. READY appears in the bottom left corner of the HUD.

   Ctrl R Open refueling hatch and send radio request for vector to tanker As flight leader, you refuel first.

2. The controller gives you heading and range to the nearest tanker. He or she updates this information until you have an air-to-air radar locked onto the tanker or are within 2 miles of it.

3. When you are 1 mile from the tanker, its pilot radios: "Clear contact." You have permission to begin lining up with the tanker's tail.

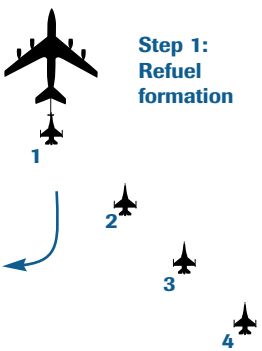
4. About 500ft from the end of the boom, you'll get cues from the tanker.

   - If you are too far up, pitch down slightly. If too far down, pitch up.
   - If you are too far forward, close your throttle bit. If you are too far back, open the throttle slightly.

   0/9 Increase/decrease throttle by 5%

   Always make very slight adjustments. The "boomer" (boom operator) also gives you audio directions until you connect.

   While you are positioning, the rest of your flight begins to line up in refueling formation on the tanker, with each aircraft 45° back and to the right of the aircraft in front of it, maintaining a 900ft spread.



Step 1: Refuel formation

5. When you are in the correct position, the boomers radios, "Stabilize," and you lose control of the aircraft. The tanker radios, "Connected. I'm seeing fuel flow" and begins to transfer fuel.

6. When the your tanks are full, the tanker radios, "Full. Clear to disconnect." To regain control of your aircraft, reduce throttle to idle. This reduces your aircraft's velocity, so it falls back away from the boom.

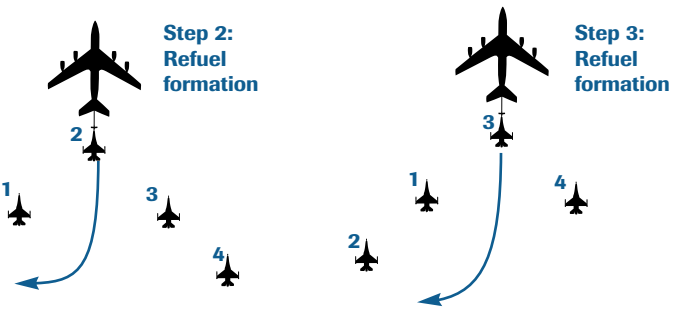
   1 Reduce speed to idle.

Caution: *Keep a very steady hand on your flight stick. Any lateral or pitch movement at this stage may cause hatch damage or malfunction. Opening throttle more than 10% while dropping back may also cause hatch damage.*

7. The tanker radios “Clear to disconnect. Good luck.”

   When you are clear of the tanker, bank to the left. When you are 300ft from the tanker, it can refuel the next aircraft.

8. Remain within three miles of the tanker while the rest of your flight refuels. As each aircraft refuels, it returns to formation on your tail.



8. After all aircraft are clear of the tanker, leave the three-mile radius. The other flights revert to standard cruise formation. Your wingman resumes wedge formation.

   When you leave the radius, other aircraft in your sortie leave at the same time, whether or not they’ve finished refueling. If an aircraft doesn’t complete the refueling process, that plane leaves with a partially full tank.

Using Night Vision Goggles (NVG)

Night Vision Goggles are optic devices which improve your vision in low-light conditions by intensifying light radiation. When NVG are enabled, the screen turns to green and black — the light bounced off of terrain and objects is intensified, and shows up as green images against the black night.

Night Vision Goggles are only functional at night.

Ctrl N Toggle night vision goggles on/off

Landing

This section provides an overview of the instruments you use to land and a basic landing sequence. We recommend you use these to familiarize yourself with basic landing procedures, and then fly the Landing training mission to get a feel for it in the cockpit.

Landing Training Mission

Have your instructor walk you through in the Landing exercise of the Basic Training series. To access this mission, select **TRAINING** from the *Main Menu* screen. When the *Training* screen appears, click **BASIC** in the upper right corner of the screen, and then click **LANDING**. Click on the plane you want to practice in, then click **LOAD**.

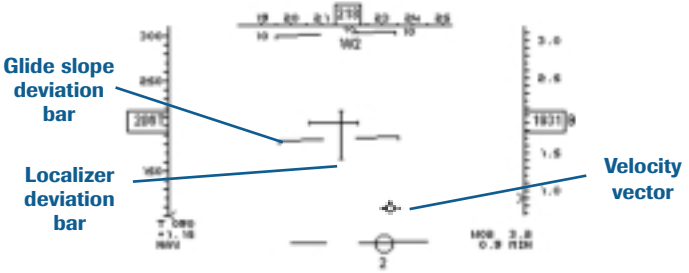
Overview of Instruments

The Instrument Landing System projects onto your HUD information that helps you line your aircraft up with the runway.

Instrument Landing System (ILS)

ILS activates automatically when the HUD is in NAV mode and you lower your landing gear. Additional symbology appears on the HUD.

- [N] Place HUD in NAV mode (NAV appears in the lower left corner)
- [G] Lower your landing gear



Localizer deviation bar. This vertical "I-shaped" line drifts left and right to indicate the aircraft's approach relative to the runway's center. Align the velocity vector with this line. (If you do so, you're on the glide path — 3° to 4° of pitch.)

Glide slope deviation bar. This is a horizontal "I-shaped" line. It drifts up and down to indicate your aircraft's altitude with respect to the runway. Center this bar and the localizer bar on top of the velocity vector to form a cross. If the velocity vector is above this bar, you're flying too high.

Caution: *If these indicators become fixed in the center of the screen and the needles are dashed lines, you have drifted too far outside ILS parameters to make a good landing. Break off your landing at this point, turn around, and re-align for another try. (See* ***Aborting a Bad Landing****, p. 3.21.)*

Basic Landing Sequence

Begin aligning with your landing waypoint about 5nm out — watch the *range to waypoint* in the lower left corner of the HUD.

1. Place HUD in NAV mode, if you haven't already.Steer so that you center the *waypoint caret* on the heading tape — this allows you to adjust your heading, without banking your wings. Maintain level flight at this point.

   [N] Place HUD in NAV mode.
   Steer slightly with the joystick to adjust heading

2. Extend your flaps. This creates additional lift during low speed flight.

   [F] Extend flaps

3. Reduce throttle to 70% and pitch the nose down 5° to lose airspeed and descend. (Place the *velocity vector* between the horizon line and the -10° line on the *pitch ladder* to pitch down 5°).

   [3] Close throttle to 70% (or use throttle device)

   [↓] Pitch nose down 5° (or use joystick)

Note: *It may seem counter-intuitive to lower the nose in order to slow down; however, as you lower throttle you reduce lift. Dropping the nose slightly counteracts this loss of lift.*

4. Make slight pitch and throttle adjustments. You should slow down to your approach speed (approximately 165 knots) and drop to 1000ft of altitude by the time you are 2nm from your landing waypoint. Extend your speed brake if needed to slow down, lower the nose slightly to speed up. Watch your *airspeed* and *altitude indicators*.

   Steer so that the velocity vector is centered on the front of the runway. This will bring you into the correct position, provided you keep your airspeed at around 165 knots.

   [↓] Lower nose slightly to speed up (or use joystick)

Note: *In general, 165 knots is an acceptable landing speed for any empty aircraft. If you're flying a fully loaded A-10A or F-4E, however, increase airspeed to 180 knots.*

5. About 2nm from the runway and at about 1,000 feet, pitch the nose up to 10 degrees and lower your gear to begin your descent. ILS information will appear on the HUD.

   [W] Pitch nose 10° up (or use joystick)

   [G] Lower your gear

6. Once you slow your approach speed, begin using your throttle to adjust your altitude and your pitch to adjust speed. Steer to center the horizontal *glide slope deviation bar* and the vertical *localizer deviation bar* over the *velocity vector*. Make very slight steering adjustments, especially as your aircraft nears the ground.

   [↑] / [↓] Pitch nose *slightly* up/down to vertically align the ILS *localizer deviation bar* vertically on the *velocity vector*

   [←] / [→] Bank *slightly* right/left to horizontally align the ILS *glide slope deviation bar* on the *velocity vector*

Note: *Although it may seem counter-intuitive, it isn't a good idea to yaw during the last phases of a landing approach. Yawing will cause the aircraft to sideslip so its nose will be aligned correctly, but the rest of the aircraft is not. Sideslip is not a problem in the air, but if you touch down, your wheels would be at an angle to the aircraft's direction of motion. Unable to roll properly, the wheels would cause you to crash.*

7. Once you are aligned, level your wings and keep your heading steady. After your aircraft touches down, cut your throttle to slow down and apply your wheel brakes to stop.

   [1] Reduce throttle to idle (or use throttle device)

   [B] Apply/release speed brakes (press and hold)

   [Shift][B] Open landing parachute (F-117A, F-4E, F-105D only)

Aborting a Bad Landing

If you're too low, too high, too fast or too slow, you may not be able to correct your landing in time. If this happens, abort the landing and try again:

1. Punch your throttle to 100% ([8]).
2. Maintain current heading.
3. Retract your flaps ([F]), speed brakes([S]), and landing gear([G]).
4. Climb back to an altitude of 6,000 feet.
5. Make a sweeping, 180° turn to the left.
6. Fly several miles past the start of the runway (at least 5nm)
7. Make another 180° turn to the left to realign yourself with the runway.
8. Straighten out and line up for another approach.

FLIGHT DISRUPTIONS

While modern aircraft have become better at overcoming aerodynamic limitations, they are still not immune to flight disruptions. This section discusses the conditions under which stalls and spins occur, and how you can recover from them.

Stall

A stall occurs when AoA exceeds maximum allowable levels for the current airspeed and a smooth airflow over the wings is disrupted. In level flight it can occur if the aircraft drops below stall speed (the minimum speed required to produce 1G of lift). In either case, lift evaporates and the airplane falls toward the earth. Knowing how to recover from a stall can be critical.

First Warning: Buffet and Tickle

As a stall approaches and the airflow over the wings roughens, the aircraft begins to vibrate, with severity increasing as the airflow worsens. The point where the vibrations or buffet first begins is called *tickle*. Pilots with a light touch can feel the tickle and realize they've reached maximum performance without looking at the instrumentation or actually entering a stall.

Second Warning: Stall Horn

If you do not take action to increase airflow, usually by relaxing G-load and pitching your nose down to reduce drag, the airflow disruption and buffeting worsens. If possible, increase speed by diving or afterburning. Fighter aircraft have a stall horn which makes a loud, distinguishable wail that warns of a potential stall.

If you still take no corrective action, and a stall occurs, the aircraft begins to fall. If in a turn, the aircraft remains banked, but stops turning and moves in a straight line tangent to the original turn circle. This is referred to as departing controlled flight, or *departure*.

Recovering

To end the stall, airflow must be re-established over the wings, which usually means increasing the aircraft's speed. Engaging afterburner in high-thrust aircraft usually provides sufficient acceleration. Many aircraft, though, cannot produce enough thrust, even in afterburner, to simply blast their way out of a stall.

Pointing the nose down quickly adds airspeed and helps re-establish smooth airflow. Of course, your airplane is dropping, so it's critical you have enough altitude available. A stall at low altitude is often fatal. Also, aircraft control decreases as the stall worsens, since there isn't enough airflow over the control surfaces. If you wait too long to begin stall recovery, you may find the aircraft uncontrollable. In that event, you're simply along for the ride and must wait until the aircraft begins to recover on its own. Again, at low altitude, you may not have enough time to wait. Keep the following guidelines in mind:

- Attempt stall recovery as soon as possible. The longer you wallow uncontrolled in the sky, the greater the chance someone will shoot you or you will crash.
- Always monitor airspeed and AoA instruments. Don't let speed drop below stall speed or AoA exceed maximum.
- Pay attention to stall tickle. If the aircraft tickles or buffets, a stall is imminent.
- Take particular care to avoid stalls at low altitude. Devote special attention to avoiding stalls near the floor. Stall recovery often requires altitude. If there isn't enough room to recover, you could buy the farm.

Spins

Spins occur when one wing loses significantly more lift than the other. The wing drops, pulling the aircraft into a rotating, spiral dive. As long as the rotation continues, most control inputs are useless, and some may even aggravate the spin.

Spins were deadly killers during the early days of aviation, before pioneer pilots discovered spin recovery procedures. Some historians estimate more World War I pilots died from spinning and crashing their aircraft than from combat with the enemy. In *USAF*, spins only occur if you use the rudder in the direction of the wing that's dropping.

Spin Recovery

Once understood, spin recovery is relatively easy, but requires prompt action. A spin may consume several thousand feet of altitude on each revolution, and spin recovery may require several revolutions. Spins at low altitude, therefore, are extremely dangerous.

Follow these steps if you find yourself in a spin:

1. Neutralize lateral stick. Using the ailerons at this point often aggravates the spin — center the joystick.
2. Apply full opposite rudder.
3. Apply forward stick. Push the stick forward to keep the nose down.
4. Maintain the current stick and rudder positions until rotation stops. You will generally find yourself nose-low at low speed and presenting a perfect target for any nearby bandits. Gently pull out of the dive, apply full power, and return to normal flight.
5. Don't panic. If you've done all of the above and the aircraft is unwilling to recover, keep your head about you and go through the procedure again. You might also try increasing your throttle in addition to the above.

4

COMBAT

Previous page:: An F-16C dispenses flares. USAF photo by Senior Airman Jeffrey Allen.

Chapter 4

COMBAT

Despite the technological advances of the last few decades, air combat still involves the same basic strategy — find the enemy before he finds you, get into an advantageous firing position, and stay there. Either way, it's to your advantage to locate the enemy before he's aware of your presence.

This chapter teaches you combat theory, air maneuvers and practical combat use of avionics and weapons against enemy aircraft and ground vehicles.

Mission Preparation (p. 4.2) goes over some basic considerations you should think about prior to taking off.

Quick Cockpit Review (p. 4.3) briefly reviews the main sections of the cockpit and refers you to additional information in **Cockpit**, p. 2.1.

Quick Navigation Review (p. 4.5) lists some common navigational commands to help you get to your target point.

Detecting the Enemy (p. 4.7) provides a lengthy discussion on ways to detect threats. It also covers in detail how to use your air-to-air and air-to-ground radar.

Using the Radar (p. 4.12) teaches you the ins and outs of the air-to-air and air-to-ground radar. You'll learn how to detect targets and read the Radar MFD page symbology.

Targeting (p. 4.23) takes you to the next level — gaining a target lock on another aircraft, ground threat and mission-critical target. It also describes how to use your aircraft's RWR, Tactical Map and JTIDS MFDs to track targets.

Using Weapons (p. 4.28) details positioning techniques, sensors, weapon types and HUD modes related to firing weapons. Most importantly, this section gives step-by-step information on how to use specific weapons in the game.

Defenses and Countermeasures (p. 4.51) elaborates on methods you can use to avoid being shot down.

Combat Tactics (p. 4.56) illustrates offensive and defensive aerial maneuvers you can use against air threats, and describes how to attack ground targets.

Communication (p. 4.71) lists key commands you can use to send messages to your wingmen, other flights in your sortie, and AWACS, J-STARS and tankers in the area.

MISSION PREPARATION

A great deal of your mission success depends on how prepared you are before you go into battle. You should become very familiar with your mission objectives, the objectives of other wings in your flight, and any expected resistance you might encounter along the way. Find out how far you must travel, and calculate how much fuel you'll need to return home. Gear your initial aircraft loadout toward your intended target(s), but don't be caught off-guard — for instance, if you're attacking ground targets, carry an air-to-air missile or two for any unexpected air enemies. If you're on a combat air patrol, take an air-to-ground weapon for any interesting ground targets presenting themselves.

In the *Loadout* screen before each mission, you can switch out weapons which appear by default on each aircraft's hardpoints. Some weapons are heavier than others, and you must keep the total aircraft weight underneath its maximum T.O.W. (takeoff weight). Also, when you're loading weapons, pay attention to the sensor system each uses. Look for IR, Laser, etc. below each weapon icon on the *Available Weapons/Equipment* panel of the *Loadout* screen.

See the **Weapon Information Chart**, p. 4.32, for weapon and sensor types.

In most missions, you fly more than one type of aircraft in a single mission. In addition, once you've completed your flight's objectives, you can jump into the lead aircraft in any other flight in the sortie by opening the *Tactical Display* screen (press Esc). So, it's obviously to your advantage to examine the objectives for each flight and adjust the loadouts as you deem necessary.

In any event, keep the following items in mind when you're preparing for a mission:

- What is your objective?
- Are there any special parameters for the mission (i.e., objects you must not hit)?
- What resistance can you expect?
- Will you have enough fuel for the mission? Enough for unexpected air encounters?
- Do all flights have a good mix of weapons to cover most situations?

QUICK COCKPIT REVIEW

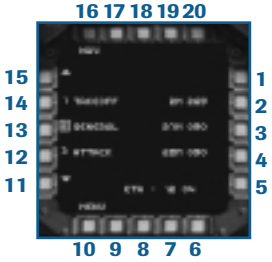
You should read **Chapter 2: Cockpit** thoroughly before reading this chapter. Combat requires knowledge of cockpit systems. But, in case you don't have the time or inclination, here's a quick overview of the cockpit.

MFD Pages

*See **Cockpit: MFD Pages**, p. 2.29.*

Multi-Function Displays, known as MFDs, display "pages" of information. Most cockpits have two MFDs, though a select few have three. You can display many different pages of information in any of the MFD screens.

Every MFD is surrounded by gray, interactive pushbuttons. You press these buttons to change settings or display various data. Throughout this manual, these buttons are referred to as PB1, PB2, etc. The button numbering is illustrated in the picture to the right.



Whenever you click **MENU** (PB10) in the bottom left corner of any MFD, this Menu MFD page displays in the MFD. This page displays the entire array of MFD pages you can activate. Left-click on the pushbutton (PB) next to any of the following names to open that page.

System	MFD Page	Menu PB	Key
Inertial Navigation System	NAV	PB2	N
Damage System	DAMAGE	PB3	D
Tactical Map/JTIDS	TACTICAL/JTIDS	PB4	T
ADI	ADI	PB5	-na-
Radar	RADAR	PB11	R
*Radar Warning Receiver**	RWR	PB12	U
Stores Management System	STORES	PB13	-na-

* If RWR is not currently displayed.

Modes

*See **Cockpit: What Are Modes?**, p. 2.2.*

Most of the aircraft systems in *Jane's USAF* use modes — the HUD, the radar, MFDs and weapon systems. A mode is simply a set of functions.

Master Modes

*See **Cockpit: Head-Up Display**, p. 2.12, and **Using Weapons**, p. 4.28.*

There are three master modes: NAV (navigation), AA (air-to-air) and AG (air-to-ground). When you select a master mode, the information displayed in your HUD and MFDs change, and your radar mode and currently selected weapon may change.

M Toggle avionics master mode (Navigation / Air-to-air / Air-to-ground)

The chart below lists default settings for each master mode. Under certain *conditions*, such as when you have your gear down or a certain weapon selected, information is added to your *HUD,* and the pages in your *MFDs* change, as indicated below. (The default mode for the radar is listed in parentheses.)

NAV Master Mode

Condition	HUD	MFD 1	MFD 2	MFD 3
Default	NAV	Tactical[3]	Radar (AA)	NAV
Gear down	ILS	Tactical[3]	Radar (AA)	NAV
Refueling hatch open	Refuel	Tactical[3]	Radar (AA)	NAV

AA Master Mode

Condition	HUD	MFD 1	MFD 2	MFD 3
Default, Gun selected[1]	LCOS	Radar (AA)	Tactical[3]	RWR
Default, Gun selected[2]	EEGS	Radar (AA)	Tactical[3]	RWR
MRM missile selected	MRM	Radar (AA)	Tactical[3]	RWR
SRM missile selected	SRM	Radar (AA)	Tactical[3]	RWR

AG Master Mode

Condition	HUD	MFD 1	MFD 2	MFD 3
Default, Gun selected	AG	Stores	Radar (AG)	Tactical[3]
GP bombs selected	CCIP	Stores	Radar (AG)	Tactical[3]
LGB bomb selected	CCIP	Stores	FLIR	Tactical[3]
TV/JDAM weapon selected	TV	Stores	TV	Tactical[3]
HARM missile selected	HARM	Stores	HARM	Tactical[3]

[1] In A-10A, F-105D, F-4E, F-117A and MiG-29. [2] In F-15C/E, F-16C and F-22A.
[3] In F-16C, F-15C/E, F-117A and F-22A, the JTIDS page replaces the Tactical page.

Multi-Function Displays

*See **Cockpit: MFD Pages**, p. 2.29.*

MFDs have many different pages you can access by using the MENU pushbutton and choosing the appropriate pushbutton for a particular page.

MENU Display MFD menu (or click PB 10 on any MFD)

Here is a list of MFD pages and their general functions:

NAV	Displays waypoint information.
DAMAGE	Displays current system status (GO/NO GO/MAL)
RADAR	Displays contact info for air-to-air and air-to-ground radars.
RWR	Displays threats transmitting active radar signals. (In some aircraft, this is also available as a separate instrument.)
STORES	Displays hardpoint status, available weapon types and counts. Also lets you select ripple-fire settings.
ADI	Displays an artificial horizon and altitude reading.
TACTICAL	Displays map and waypoint information.
JTIDS	Displays map and combined data from radar, RWR, JSTARS and AWACS. It shows friendly status, friendly and enemy radar locks, and air and ground targets.
FLIR	Displays FLIR and targeting info for laser-guided weapons.
HARM	Displays optical and target info needed to fire HARM missiles.
TV	Displays optical and target info needed to fire TV-guided missiles.

Weapons

You can fire air-to-air weapons when in AA master mode, and air-to-ground weapons when in AG master mode. When you select a weapon, additional symbology you need to fire or drop it is added to your HUD, and your MFD pages may change.

] / [Cycle through air-to-air/air-to-ground weapons

See **Using Guns** (p. 4.36), **Using Rockets** (p. 4.38), **Using Missiles** (p. 4.39) and **Using Bombs** (p. 4.46).

Radar

The radar has both A/A and A/G modes. Under each of these modes are several submodes with specific applications Some A/A submodes are better at long-range searches, while some are best at short-range searches. In A/G mode, the radar has separate submodes for detecting stationary and moving targets.

R Toggle between A/A and A/G radar modes

Q Cycle through radar submodes

Shift R Toggle radar between standby (not emitting) and on

QUICK NAVIGATION REVIEW

To learn about navigation in detail, see **Flight: Navigation**, p. 3.11.
For Tactical MFD symbology, see **Cockpit: Tactical MFD Page**, p. 2.39.

Before you can engage in combat, you need to arrive at the specified target area. Several navigation utilities in the game help you fly from one waypoint to another. All aircraft have a NAV mode for the HUD, and a Tactical MFD.

Below are some basic navigation keys:

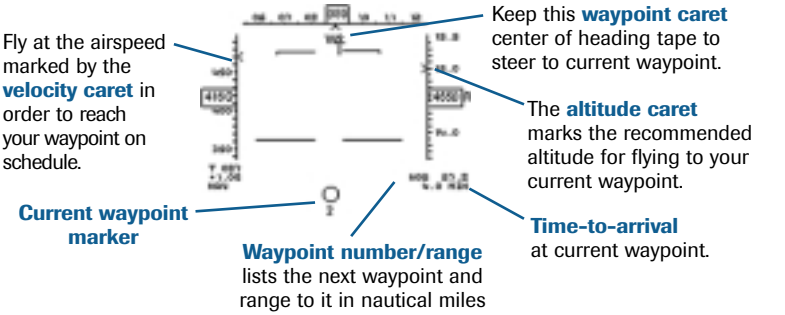
N	Place HUD in NAV mode
W	Select next waypoint
Shift W	Select previous waypoint

- The waypoint caret appears on the heading scale in all HUD modes. The range to the next waypoint, however, only displays in NAV HUD mode.
- If you'd rather not navigate manually at all, you can always use the game's autopilot system.

A x 2 Autopilot to the next waypoint (see **Flight: Autopilot**, p. 3.14)

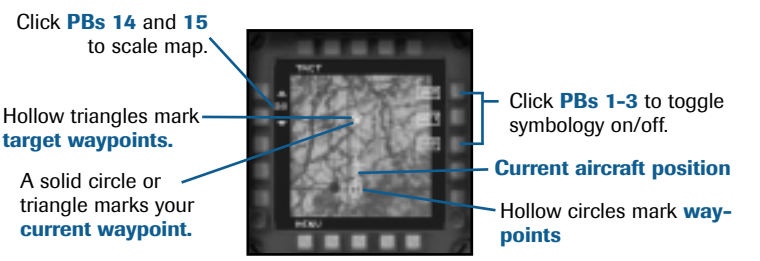
HUD in NAV Mode

See **Cockpit: Navigation HUDs,** p. 2.16



Tactical MFD Page

See **Cockpit: Tactical MFD Page**, p. 2.39



DETECTING THE ENEMY

Over the past few decades, advances in detection technology have spawned an entirely new type of air-to-air combat. Radar and infrared guidance systems, nighttime visual enhancers and stealth technology have extended the combat range to several miles. Fighters no longer *had* to see one another to engage in battle. Long-range detection became an advantage for attacking for air- and ground-based targets.

Several air-to-air fighters were designed specifically for BVR (beyond visual range) battles and not equipped with even the smallest of guns. This was a definite disadvantage in the Vietnam War, however, against the fast-turning Soviet MiG fighters. Based on hindsight, almost all air-to-air fighters developed after the war were fitted with dependable, short-range guns. Today, most combat takes places with missiles at long range, although close-in dogfighting is still a common occurrence.

Detection Systems

First and foremost in combat, you need to preserve the element of surprise and detect your unsuspecting enemies before they spot you. In air battles, gaining even a hundred feet of altitude advantage against your opponent can give you a speed boost when you need it most. Coming in on your enemy's six gives you a significant upper hand during your initial attack.

If you can't make it to the target area undetected — perhaps the length of your mission requires you to fly at a higher altitude to conserve fuel — your next best strategy is taking out the air opposition with a single pass, before they have a chance to lure you into a dogfight. Doing this requires great skill.

New detection methods allow for more stealthy air-to-ground attacks against strategic targets, such as airfields and communications centers. You have several methods of detection at your disposal, depending on which aircraft you're flying. The oldest and sometimes most useful device is your eyeballs. Modern detection methods include active radar, passive radar (RWR), and infrared (FLIR) detection systems, discussed in the following sections.

Natural Eyesight

- Use your eyes for air (or ground) targets within visual range.
- The Numpad keys are very useful visual aids during combat. Use the "check six" key (Numpad 2) liberally to keep an eye on your rear.
- At night, you can use night-vision goggles to enhance your natural vision (press Ctrl N. They amplify the available light source.

Don't discount the advantage of having 20/20 or better vision during combat. You can always rely on eyesight, often referred to as the "Mark I eyeball" detection method. With a keen eye, for instance, you may be able to pick up enemies above while you're cruising safely along in low-level flight and trying to avoid radar detection.

Another instance in which eyesight can be particularly useful is during close-range air combat. At ranges of less than a couple of miles, you probably already know an enemy is around. Your missile guidance systems won't work at that distance, so guns are the normal modus operandus. An onboard lead-computing gunsight system (in some fighters) can help you get a good bead on your enemy, but in many cases, you have to rely on your instinct for a quick snap shot or close-range missile shot.

You'll find several of the game's camera views useful during combat. You can "open up" your view by removing the HUD, follow your target, track an incoming missile, and more. (See **Cockpit: Cockpit View Controls**, p. 2.48, or the printed *Reference Card* for a complete list of views.)

F1 **Cockpit/HUD View.** Toggle view that displays either the physical cockpit or full-screen HUD view.

F3 **Padlock Target View.** Interior cockpit view that points your "eyes" directly at the currently locked target. Even if the target isn't in your HUD view, this view still looks in the direction of the target.

F4 **Target View.** External view of your current target.

F5 **Player–Threat View.** External view of your aircraft that lines the camera up with your aircraft and the closest inbound missile.

F6 **Player — Wingman View.** External view of your aircraft that lines the camera up with your wingman. Press this key multiple times to cycle through other aircraft in your flight.

F8 **Arcade View**. External view of your current target that lines the camera up behind your aircraft in a "chase view."

F7 **Player — Target View.** External view of your aircraft that lines the camera up with the current radar target. Press again to reverse the view.

F10 **Chase View**. External view of your aircraft. Press multiple times to view close-ups of parts of your aircraft. Press Shift F10 to switch to an external orbit view. To pan this view, use Numpad 2 4 6 8 or the mouse.

F11 **Weapon View.** External view of your missile that lines up with the current target.

Active Radar

- Use active radar to find air targets when you're using radar-guided weapons.
- Be aware that if your radar is on, air- or ground-based enemies can detect your radar signals and find you.

Active radar sends out pulses or waves of electromagnetic energy. This energy "bounces" off objects it hits, and some waves are reflected back. Your onboard computer examines how strong the reflected waves are, what frequency shift occurred, and how long the waves took to return. With this information, the computer can determine the approximate distance, altitude, direction and speed of the object. (See **Using the Radar**, p. 4.12.)

While active radar is a primary detection method, it can also be used to guide certain weapons — the AIM-7F, AIM-7B, and AIM-120. Its function as a weapon guidance tool is covered in **Know Your Guidance Systems**, p. 4.34.

[R] Toggle air-to-air/air-to-ground radar modes

[Q] Cycle through radar submodes (air-to-air — LRS / TWS / ACM or air-to-ground — MAP / GMT) (Or click PB16 on the Radar MFD)

[Shift][R] Toggle radar standby

[<] / [>] Increase/decrease visible range in Radar MFD (or click PBs 14 and 15).

Passive Radar (RWR)

- Use passive radar to detect air or ground targets emitting radar.
- You can use your RWR to detect targets up to 50nm away.

Passive radar systems receive radar waves or pulses instead of broadcasting them. They can detect ships, other aircraft, ground vehicles and radar stations emitting radar energy. Although it's primarily a defensive device, you can use the RWR to stealthily detect your enemies. Instead of flashing your active radar for a quick peek at your surroundings, look at your RWR.

Information received by your passive radar gets sent to your RWR MFD, a pop-up window that displays in your front cockpit view when RWR is active. You can lock onto targets in the window once you've detected them and met the requirements for the currently selected weapon (for instance, range). Your RWR can also warn you about incoming, radar-guided missiles from other aircraft or surface-to-air missile sites. See **Cockpit: Radar Warning Receiver (RWR) MFD Page**, p. 2.38, for a complete discussion of RWR symbology.

[U] Toggle RWR MFD

Forward-Looking Infrared (FLIR)

- Use FLIR to detect targets out of visual range when you're using IR weapons against ground targets.
- All aircraft in the game are automatically outfitted with an internal FLIR system. You don't need to load special pods in order to use this detection method. The exception is the F-4E — in this aircraft, you must load the AVQ-26 LANTIRN pod to have FLIR capabilities.

Forward-looking infrared devices paint rough pictures of objects based on their heat emissions. IR sensors, housed in a Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) pod, search for specific heat frequencies. An onboard computer translates the heat readings into pictures and displays them in the FLIR MFD Page.

More similar to a RWR than an active radar, FLIR simply picks up energy instead of emitting it. In this respect, using it doesn't entail much risk. Your enemies cannot detect you when FLIR is active — activating FLIR doesn't send out any energy. Instead, it looks for objects "hotter" than their surroundings. For this reason, FLIR is especially helpful at night against low-flying or grounded objects.

The FLIR pod is used in conjunction with IR-guided missiles. It allows target acquisition (in ACTIVE mode) and laser guidance (in PASSIVE mode). The pod itself has three main sections. The FLIR head provides a green-and-black infrared MFD image. A laser indicator sends out a laser beam to designate targets for laser-guided bombs, and a laser receiver detects laser designations from other sources.

One real drawback to FLIR technology is the fact that it operates at limited range. If the weather is foggy or cloudy, it becomes less effective. But since FLIR can detect both air and ground targets, it is somewhat more versatile than active radar. IR guidance technology also helps guide several types of weapons — for instance, AA-8, AIM-9L and AIM-9M air-to-air missiles and laser-guided GBU-series bombs. The FLIR's function as a weapon guidance system is covered in **Know Your Guidance Systems**, p. 4.34.

[I] Display FLIR MFD information

J-STARS/AWACS/EWR

AWACs, J-STARS and EWRs can give you information on radar targets from other aircraft without using your aircraft's radar to scan for them. They detect targets with their powerful radar and then broadcast messages about targets in your area. These cues also display in text form at the top of the screen.

- An AWACS controller always identifies itself with a callsign, which is different for each campaign.

Buckeye	Desert Storm, Red Flag and Training missions
Big-Bird	Future and Domestic missions
Red Crown	Vietnam (ship-based; located in Hai-Phong Bay)

- When you fly the F-22A, F-117A, F-15C, F-15E or F-16C, the Tactical MFD is replaced by the Joint Target Information Distribution System (JTIDS) MFD, which displays additional radar, RWR and AWACS/J-STARS contact data.

In modern warfare, communication has become an integral part of target detection and tracking. Two types of aircraft were developed for this purpose: the AWACS (Airborne Warning and Control System) and the J-STARS (Joint Surveillance and Target Attack Radar System). AWACS aircraft report air targets, while J-STARS pass along information about ground threats. These high-flying aircraft do nothing but find enemies and hand off target information to flights in the area or to ground commanders. This system allows attacking aircraft to get accurate position and altitude information about targets without exposing themselves via their own onboard radar systems.

In addition, Early Warning Radar (EWR) sites were used in Vietnam to transmit intelligence from ground controllers to overflying aircraft.

Friend or Foe?

- IFF is automatically active and cannot be deactivated.
- Friendly aircraft have an "X" in the target designation box when targeted.
- If your AA radar is on and you enable **OBJECT ID ON TD BOX**, all targeted aircraft are identified by name in the HUD above the target designation box. (See *Preference* window under **GAMEPLAY > OTHERS**.)
- Other aircraft send radio messages to alert you to enemy aircraft.
- Press F4 to view a closeup of your current radar target.

Before you fire on a target, always verify it's an enemy instead of a friendly. The importance of target identification has increased with BVR combat and the increasing use of coalition-type forces in worldwide hotspots. All aircraft in this game are equipped with Identification Friend-or-Foe (IFF) equipment, or interrogation transponders. Friendly aircraft automatically emit a specific beacon or code when targeted by a fellow aircraft. The pilot's IFF box "answers" the aggressor's box, and his transponder returns a "friendly" message when queried (or "squawked") by another allied aircraft. Onscreen, this places an "X" in the target designation box for a friendly target.

USING THE RADAR

Since the radar is vital to your survival in the air, it is imperative you become familiar with its different modes and comfortable managing it during combat. The following sections describe each radar mode in detail.

You can activate radar functions with the mouse or keyboard, or assign functions to your programmable joystick. Most players use the keyboard for the cockpit systems and the joystick for flight control, but you should find the setup that works for you.

Main Radar Controls

The following are the main radar functions, organized by how you might use them while acquiring, targeting, and attacking an enemy.

- R — Toggle air-to-air/air-to-ground radar
- Q — Cycle through radar submodes:
  Air-to-air radar — LRS / TWS / ACM
  Air-to-ground radar — MAP / GMT
- Enter — Select target/next target
- Bksp — Release current target and start scanning
- < / > — Increase/decrease visible range in Radar MFD (or click PBs 14 and 15).

When you press Enter, the radar chooses the next highest priority contact and designates it as the priority target. In LRS, ACM, and Boresight modes (air-to-air modes), the radar automatically switches into Single Target Tracking (STT) submode when you lock onto a target.

Radar Submodes

The correct radar submode is *not* automatically activated when you select a particular weapon. You must manually toggle the correct mode with R and/or Q. Each radar submode is discussed fully later in this section.

Flight Only

Condition	Radar Mode
Takeoff & Landing	LRS
Cruise Flight	LRS

Air-to-Ground Combat

Condition	Radar Mode+
AG (Dumb Bombs)	MAP or GMT
AG (Laser-Guided)	MAP or GMT
AG (Gun)	MAP or GMT
AG (TV Missiles)	MAP or GMT
AG (HARM Missiles)	MAP or GMT

Air-to-Air Combat

Condition	Radar Mode
AA (Long Range)	LRS or TWS*
AA (Short Range)	ACM or BORE*
AA (Gun)	ACM or BORE*

* Single-Target Tracking (STT) submode activates automatically when you acquire a target using one of the other two methods listed.

+ Map mode detects stationary targets, while Ground-Moving Target mode detects moving targets.

Air-to-Air Radar Submodes

All aircraft in the game are equipped with a radar system that has several air-to-air radar submodes. By default, the air-to-air radar is active when you take off, and it's in LRS submode.

The current radar submode (STBY, LRS, TWS, ACM, STT, BORE or AA CHEAT) appears in the upper left corner of the Radar MFD.

An air-to-air radar lock won't break, even if you switch submodes while you have a locked target. The only exception is when the new submode has a smaller range than the initial one — in the new submode, the radar can't see the target because it's out of range.

Q Cycle through radar submodes (air-to-air — LRS / TWS / ACM or air-to-ground — MAP / GMT) (or click PB16 on the Radar MFD)

Off. The radar is not active (i.e., the aircraft's engines are off).

Standby (STBY). The radar is powered, but not transmitting anything.

Shift R Toggle radar standby

Long-Range Search (LRS). Long Range Search submode facilitates the detection of enemy targets before they discover you. Use it when you are flying in what seem to be clear skies. It has the longest range, but shows the least information.

Track-While Scan (TWS). To track and prioritize targets, switch to Track While Scan. This submode has a shorter range than LRS and can track a target while still scanning other targets.

Air Combat (ACM). In Air Combat submode, the radar fully automates the selection of targets so you can concentrate on aiming and firing weapons. It has the shortest range, however.

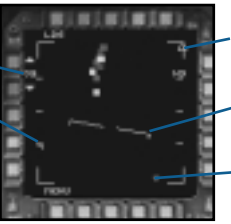
Boresight (BORE). A short-range submode, BORE mode can get you a fast lock on a target if it is within the HUD frame. The radar rapidly targets and acquires any object within ten nautical miles if it is visible inside the HUD frame. It's useful in close-range dogfights when you can't find the enemy.The player must not have a target currently selected to use this. Press Bksp to break lock, then use Boresight (press \).

Single Target Track (STT). A sub-mode of LRS, boresight, and ACM modes, Single Target Track helps to acquire and hold onto a feisty enemy. When you have acquired a single enemy on radar, it shifts to this mode automatically. This mode is essential for semi-active radar missiles. It gives the most target information available.

AA CHEAT. The game has a cheat mode you can enable by selecting ENABLE CHEAT RADAR from the *Preferences* menu. In this mode, you have access to a continuous, 360° scan of the airspace around you.

Common Elements in Air-to-Air Submodes

Each air-to-air radar submode uses the elements listed below.



Current visible range. The AA Radar MFD is capable of displaying ranges from 5nm to 80nm (the LRS submode extends to 160nm in some aircraft).

[<] / [>] Increase/decrease visible range in Radar MFD
or PB 14/15 (5 / 10 / 20 / 40/ 80nm — 160 in some aircraft/LRS only)

Horizon line. This line shows the horizon. When you fly level, it's horizontal. The angle changes as you bank and moves up/down as pitch changes.

Antenna azimuth and elevation carets. The caret on the left of the Radar MFD represents the radar's current vertical scan position (elevation). The caret on the bottom represents current horizontal scan position (azimuth).

Waypoint symbol. The small triangle indicates the position of your current waypoint.

Cursor. (Not shown) When you move the mouse cursor over the MFD, two lines form a bracket. Move this cursor over a target and left-click to acquire it.

Air Combat (ACM) Submode

Max range	10nm	**Altitude parameters**	>30m AGL
Azimuth scan	±60°	**Airspeed parameters**	>0 knots
Elevation scan	±60°	**# of Targets tracked**	15

ACM submode is an entirely automatic target acquisition submode. It's best applied in short-range combat — this lets your onboard computer handle all radar and targeting functions and leaves you free to fight.

In this submode, the radar locks onto the first target entering its scan zone and auto-switches to STT submode. (See **Single-Target Track Submode**, p. 4.18.) As soon as you're in weapon range, you can fire.

Although this submode is more automated than the others, you can still control some of its functions. If you release a target with [Bksp], the radar reverts back to ACM submode, acquires a new target, and resume STT submode. If it can't find another target, the radar stays in ACM mode.

[Bksp] Release current target / acquire new target (automatically activates STT mode once a new target is acquired)

Long Range Search (LRS) Submode

Max range	80nm	**Altitude parameters**	>30m AGL
Azimuth scan	±60°	**Airspeed parameters**	>0 knots
Elevation scan	±60°	**# of Targets tracked**	15

LRS submode lets you acquire targets at the longest range — 80 nautical miles. By identifying a target early, you have the maximum amount of time to identify the target and prepare for combat against identified bandits. The available ranges (in nautical miles) are 5 / 10 / 20 / 40 / 80.

Of all the air radar submodes, LRS provides the best detection capabilities, but it provides no initial information about targets other than their locations. You can't tell, for instance, a target's closure speed.

Once the radar picks up a target in LRS submode, the target appears on the Radar MFD as a dot. The brightest dots represent the most recently detected targets, while the dimmer one represent older targets.

You can lock onto the target two different ways, and you can release a locked target and continue scanning in LRS submode:

Enter — Acquire nearest target

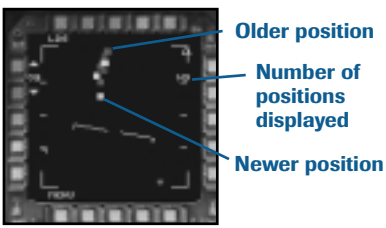
Left-click on a target in the Radar MFD to acquire it (Does not work if you're playing in full-screen mode)

Bksp — Release current target

- Once you've locked onto a target, the radar mode switches from LRS to STT. See **Single-Target Track Submode** (p. 4.18) for details.
- If you think there are additional targets in the area, you can resume scanning in LRS mode or TWS mode to acquire them.

Additional Symbology

History. The scan refreshes the radar view every four seconds. By selecting a history setting, you can watch a target's progress over time. Each target displays its current position (a bright dot), along with up to three additional dim "history" dots showing its previous positions.



PBs 1/2 — Increase/decrease the number of positions displayed (H1, H2, H3, H4) per contact.

Track While Scan (TWS) Submode

Max range	40nm	**Altitude parameters**	>30m AGL
Azimuth scan	±60°	**Airspeed parameters**	>0 knots
Elevation scan	±60°	**# of Targets tracked**	15

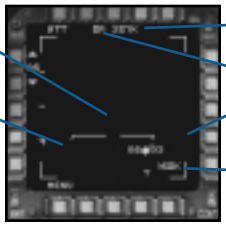
In Track While Scan submode, the radar performs multiple detections of targets to calculate their vectors within the radar's field of view. The radar can track up to fifteen different targets simultaneously, displaying the position and direction of flight for all targets. Because of its greater precision, TWS has a shorter range than either the LRS or STT mode. The available ranges (in nautical miles) are 10 / 20 / 40.

The first target the radar scans is designated as a *priority target*. This target is scanned more thoroughly than the other undesignated targets in view, and it's scanned similarly to an STT target. This means you can view more information about this target than the other targets on your MFD. (See **Single-Target Track Submode**, p. 4.18).

You can designate a different priority target by left-clicking on any of the targets in the Radar MFD. To lock onto a priority target, left-click on it again.

Select priority target(or, if the target is already a priority target,lock onto the target)	
x 2	Lock onto a priority target (activates STT radar mode)
Enter	Let computer designate priority target / select next target
	View target range/radar history (move mouse over target)

- When you fire a semi-active radar missile (such as the AIM-7), the radar switches to STT submode for that particular target.
- This mode gives you the most information about all targets at once, and lots of information about your priority target.



Additional Symbology

Undesignated target icon. These small squares represent undesignated targets. The tail on each square represents the threat's current direction of flight.

Priority target icon. The first target the radar comes across in its scan is designated as the *priority target*. It has a star-shaped icon around it, and it is brighter than other targets in the Radar MFD. The altitude, velocity, aspect angle and closure speed for this priority target appear at all times as long the target remains in the Radar MFD page. You can designate a different priority target by left-clicking on an undesignated target icon or pressing Enter to cycle through targets.

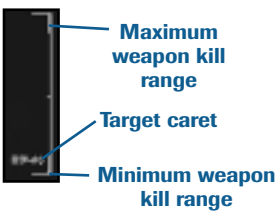
Target altitude/Mach speed. (Not shown; see **Single-Target Track Submode,** p. 4.19) The target's altitude in thousands of feet appears to the left of the target icon.). The target's mach speed also appears (right number). This symbology only appears when you move the cursor over target.

Target velocity. The target's current airspeed, in knots.

Target aspect angle. The angle of the target's nose in relation to your aircraft's nose, in 10° increments. 7R, for instance, represents 70° to the right.

Closure speed. How fast the target is flying toward or away from you. High, positive numbers mean you're closing in on the target, while low, negative numbers mean the target is slowly pulling away. This indicator slides up and down the DLZ, and the closure rate appears numerically next to it.

Dynamic Launch Zone (DLZ). A small ladder scale indicating your missile's range and the target's current range in relation to your radar's maximum range. The thick lines show the minimum and maximum weapon kill range for your currently selected air-to-air missile. The number and the small caret to the left of the line shows the target and its closure speed.



When the target caret slides within the weapon's kill range line, you can fire your weapon.

AA Cheat Submode

Max Range	80nm	**Altitude parameters**	None
Azimuth scan	±360°	**Airspeed parameters**	None
Elevation scan	±360°	**# of Targets tracked**	All visible

If you have ENABLE CHEAT RADAR activated in the Options menu, the radar enters AA cheat submode. This mode operates similarly to TWS submode, with a couple of exceptions. First, the radar has a 360° view. Secondly, the radar does not automatically switch to STT submode when you fire a medium-range missile at a locked priority target.

The symbology for AA Cheat mode is identical to the TWS symbology.

Boresight (BORE) Submode

Range	10nm	**Altitude parameters**	>30m AGL
Azimuth scan	+/-60°	**Airspeed parameters**	>0 knots
Elevation scan	+/-60°	**# of Targets tracked**	1

During dogfights, you may want to get a fast lock on a target directly in front of you. Boresight (BORE) submode is useful in this situation because it automatically acquires the first target in your immediate visual field of view.

Boresight submode has a very narrow and short scanning range. It locks onto the first target to come into your front view.

To use Boresight submode, point your HUD at the target, and press and hold \. The target is automatically acquired. Release the key, and the radar enters STT submode. (See **Single-Target Tracking (STT) Submode**, facing page.) If you have not acquired a target, releasing the key returns the radar to the previous mode.

\ Activate boresight mode (press and hold)

Single Target Track (STT) Submode

Range	80nm	**Altitude parameters**	>30m AGL
Azimuth scan	+/-60°	**Airspeed parameters**	>0 knots
Elevation scan	+/-60°	**# of Targets tracked**	1

Single Target Track (STT) submode helps you maintain a radar lock on a single target. The radar tracks the target as long as you keep it within the azimuth and elevation scan ranges. The radar view refreshes itself several times each second, and adjusts the range setting according to how far away the target is. If the target is close enough to be tracked with the next-smallest range setting, that setting is chosen.

You can't actually select STT submode from the MFD or menus — instead, it activates automatically when you acquire and lock onto a single target in LRS, TWS, BORE or ACM submodes.

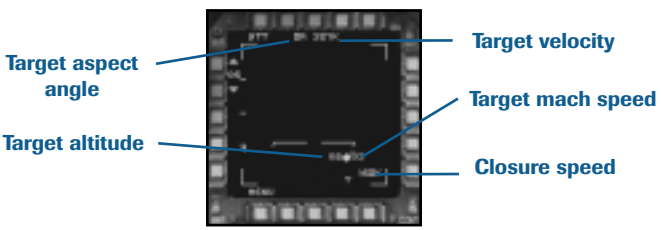
In STT submode, only one target appears on the screen at a time. Radar data is fed directly to your currently selected weapon system and to the gun reticule calculator. You can see a lot of information about your target on the MFD, including the target's altitude (in thousands of feet), closure rate, and speed.

Enter Switch to next target

Bksp Release current target (also switches radar to LRS submode)

- TWS gives the most information for target tracking and missile launches.
- For short-range targets, STT submode focuses the radar on a single target so you can launch missiles against it. At the shortest ranges, use STT to make the kill, or switch to BORE submode for targets you are trying to keep in front of your plane.

Additional Symbology



Target altitude/mach #. The target's altitude in thousands of feet appears to the left of the target icon.). The target's mach speed also appears (right number). This symbology only appears when you move the cursor over target.

See **Track While Scan (TWS) Submode**, p. 4.16, for definitions of the other symbology.

Air-to-Ground Radar Submodes

Your aircraft's radar has several air-to-ground radar submodes. The current submode (STBY, MAP OR GMT) appears in the upper left corner of the Radar MFD.

Off. The radar is not active (i.e., the aircraft's engines are off).

Standby (STBY). The radar is powered, but not emitting anything.

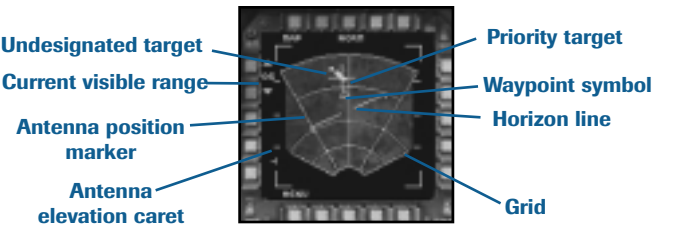
Map (MAP). Map submode scans the terrain and displays the radar image of it on the MFD. Large or radar-reflective objects appear as dots on the map display.

Ground-Moving Target Identification (GMT). When objects move on the ground, you can track their progress when the radar is in GMT submode. It's good for distinguishing moving targets from stationary ones.

AG Cheat. The game has a cheat mode you can enable by selecting ENABLE CHEAT RADAR from the *Preferences* window. In this mode, you have access to a continuous, 360° scan of the ground around you.

Common Elements in Air-to-Ground Submodes

All air-to-ground modes use the same map elements, which are detailed below.



Grid/map contour. The radar grid appears as a background in all AG radar modes, but doesn't represent anything other than a 4 x 4 division of space. In Map mode, a terrain contour map also displays behind the grid and shows terrain features.

Current visible range. The Radar MFD is capable of displaying ranges from 5nm to 40nm (80 in some aircraft). The current range appears on the Radar MFD.

PBs 14/15 Decrease / increase visible range (5 / 10 / 20 / 40 nm) (80nm in some aircraft)

Antenna elevation/azimuth caret. The caret on the bottom of the Radar MFD represents the radar's current horizontal scan (azimuth) position. The caret on the left represents vertical scan (elevation) position.

Undesignated targets. Small squares represent threats detected by the radar.

Priority target. When you left-click on a target, a bright cross hair appears over it and remains on the MFD display. You can designate a different priority target by left-clicking on another threat icon or pressing Enter to cycle through targets.

If you're in GMT submode and double-click on a target, it becomes a GMTT target, and the radar tracks its movement.

Horizon line. This line simulates the horizon. When the aircraft is flying straight and level, the line is horizontal. The angle of the line changes when you bank, and it moves up and down when you change pitch.

Waypoint symbol. The small triangle indicates the position of your current waypoint. Steer toward the symbol to get to the next waypoint.

Cursor. (Not Shown) When you move the mouse cursor over the MFD, two vertical lines form a cross hair and show your cursor position. Move the cursor over a target and left-click to it. Left-click anywhere on the MFD to designate a target for bombs and laser-guided weapons.

Map Submode

Range	80nm	**Azimuth scan**	±120°

MAP submode is most suitable for striking stationary objects on the ground. In this submode, the radar scans the terrain below and displays contours onto the Radar MFD screen, regardless of weather and visibility conditions. The available ranges (in nautical miles) are 5 / 10 / 20 / 40nm. (The range in some aircraft extends to 80nm.)

Large objects, such as control towers and vehicles, appear in MAP mode as solid blips. These objects can be targeted and designated for the weapons system.

By using the pushbuttons, you can adjust the range of the ground radar. Finally, you can designate a priority target in the Radar MFD by left-clicking on it, or by pressing Enter to select the next closest target. When you acquire a target, a priority target icon appears on the Radar MFD screen, and a target designation box surrounds the target in the HUD.

Enter — Switch to next target

Alternatively, left-click on the target in the Radar MFD to acquire it.

Bksp — Release current target (automatically switches radar to LRS mode)

< / > — Decrease/increase map range (or click PBs 14 and 15 on the Radar MFD)

Ground Moving Target (GMT) Submode

Range	80nm	**Azimuth scan**	±20°

While Map submode can detect either stationary or moving targets, GMT submode can only spot moving targets. You use GMT submode to track, acquire and attack targets on the ground or water. It's primarily useful against tanks, convoys, ships, and other moving targets.

Targets appear on the Radar MFD as blips. Once a target is detected, you can press Enter or left-click on it to designate it as a ground-moving target track (GMTT) target. This locks onto the target so you can use your air-to-ground weapons against it.

When you activate GMT mode, the radar begins scanning the area for moving targets. You can adjust the radar range. The available ranges (in nautical miles) are 5 / 10 / 20 / 40nm. (The F-15E's range extends to 80nm.)

Enter — Switch to next target

Alternatively, left-click on the target in the Radar MFD to acquire it.

Bksp — Release current target

< / > or PB 14/15 — Increase/decrease visible range in Radar MFD (5 / 10 / 20 / 40/ 80nm)

AG Cheat Submode

Range	80nm	**Azimuth scan**	±360°

The air-to-ground radar has a cheat mode you can enable by selecting ENABLE CHEAT RADAR from the Preferences menu. Instead of the usual 120° scan, it provides a 360° scan of the ground around you. You can detect targets in front of you, to either side of you, below you and behind you.

Functionally, the radar operates similarly in AG Cheat mode and GMT mode. The one exception is *all* moving targets have tails indicating their direction of movement. Other targets appear as small squares with a hole in the center.

TARGETING

Targeting involves many complex systems, but it's not really difficult. In basic terms, you just need to **activate the correct master mode** (AA for air targets, or AG for ground targets) and **select a radar submode** (the default mode usually works just fine). Then, it's just a matter of pressing Enter or letting the radar auto-acquire targets for you.

To find the currently selected target, look for a green Target Designation box in the HUD. (It appears around the currently selected target.) Make sure the target isn't friendly (i.e., there's no "X" in the TD box). Then, activate the correct weapon, move in range, and fire. That's it.

M	Toggle avionics master mode (Navigation / Air-to-air / Air-to-ground)
Enter / Ctrl Enter	Select next/previous radar target
F4	View currently selected target
F7	Activate LOS view from your aircraft to your target
F7 x2	Activate LOS view from your target to your aircraft

This section discusses basic methods for targeting both aircraft and ground objects. For more details, read over **Using the Radar**, p. 4.12, and the "how to use" instructions for each weapon type. The acquisition and lock requirements differ slightly between weapon types and radar modes.

Easy Targeting

If you don't really want to target objects manually, the game has a few options to help make it easier.

Enable Cheat Radar. From the *Preferences* window, you can select a cheat mode that gives you a continuous, 360° scan of the airspace or terrain around you.

Air Combat Mode (air-to-air only). This air-to-air radar mode automatically acquires targets for you as soon as they fly into your radar's scan view.

Easy Targeting. Also from the *Preferences* window, you can select the EASY TARGETING. This displays the TD box outside of the HUD and let you maintain that target lock even if the radar target is out of view.

Note: *You can press Alt I to display colored squares in the HUD that represent nearby friendly and enemy aircraft. Red boxes denote enemies, while blue ones denote friendlies. Small pointers indicate the aircraft's direction of flight.*

Targeting Aircraft

You use your air-to-air radar to detect and target airborne enemies. Keep in mind, however, that you're vulnerable and very visible to enemy RWRs whenever the radar is active.

Follow these steps to target an aircraft using your radar:

1. Turn on your radar if it is not active (press R).
2. Switch to AA radar mode if not in it already (press R).
3. Select a radar search submode (press Q). See p. 4.13 for details on the submodes.
4. Lock onto the target:
   - For the LRS and TWS submodes, press Enter, joystick button 3, or left-click on the target in the Radar MFD.
   - In ACM submode, the radar automatically locks onto the first target it finds.
   - For BORE mode, press \ to lock on a target in the boresight field of view.
5. The radar search mode automatically switches to STT if you designate a priority target.
6. To release a target, press Bksp or put your radar on standby by pressing Shift R.

Targeting Ground Objects

Use the air-to-ground radar to find ground-based enemies. As with the air-to-air radar, activating your radar makes you visible to enemy RWRs.

Follow these steps to target a stationary ground object using your radar:

1. Turn on your radar if it is not active (press R).
2. Switch to AG radar mode if not in it already (press R).
3. Select Map submode (press Q or click PB16).
4. Press Enter or joystick button 3 to lock onto the target. Or, left-click on a target in the Radar MFD.
   - The target you lock onto becomes the priority target and has a set of bright cross hairs on top of it.
   - A green target designation box appears in the HUD whenever the target is in your field of view.
   - If you can see the object on your radar, you're close enough to lock onto it.
   - You can also left-click on a ground target in the Radar MFD to designate it as a primary target.
5. To release a target, press Bksp or put your radar on standby by pressing Shift R.
   - If you're using the LANTIRN pod in active mode, its FLIR camera can automatically lock onto targets it detects in its field of view. See **Cockpit: FLIR MFD Page**, p. 2.42, for details.

Follow these steps to target a moving ground object using your radar.

1. Turn on your radar if it is not active (press R).
2. Switch to AG radar mode if not in it already (press R).
3. Select GMT submode (press Q or click PB16).
   - Press Enter or joystick button 3 to lock onto the target. Or, left-click on a target in the Radar MFD.
   - The target you lock onto becomes the ground-moving tracked target (GMTT) and has a set of bright cross hairs on top of it.
   - A target acquisition box appears in the HUD when the target is in view.
5. To release a target, press Bksp or put your radar on standby by pressing Shift R.
   - Again, the LANTIRN pod can detect and acquire targets when in active mode. See **Cockpit: FLIR MFD Page**, p. 2.42, for details.

Viewing Threats in the RWR

The radar warning receiver (RWR) in your aircraft detects anything transmitting active radar signals within its range. It gives you a full 360° view in an approximately 20nm circle around your aircraft. Any threats inside this radius display on the RWR. Most aircraft have an RWR MFD. However, some aircraft have a physical RWR instrument on the cockpit dash.

Part of the RWR's job is to classify threats. Each threat has a specific icon that displays inside the RWR circle:

 Air threat  SAM threat  Anti-aircraft artillery

 Boat Gundish

GROUND		AIR			
Threat	**Code**	**Threat**	**Code**	**Threat**	**Code**
SA-2	2	MiG-21	21	F-117	17
SA-3	3	MiG-23	23	A-10	A1
SA-5	5	MiG-25	25	F-111	11
SA-6	6	MiG-29	29	F-4	4
SA-8	8	SU-22	22	F-15	15
SA-10	10	SU-24	24	F-16	16
Hawk	H	Su-35	35	F-22	F2
ZSU-23X4	A	Mirage F-1	M		
General AAA	A	F-105	05		

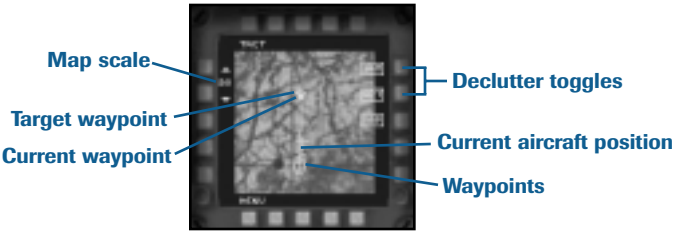
A blinking icon indicates the threat has launched a missile.

Threat codes give more specific information about the type of threat.

Viewing Threats in the Tactical MFD

The Tactical MFD shows you a general geographical outline of an area, with additional information about ground targets overlaid on top of it. The background map scrolls and displays new terrain as you fly over it. You can zoom this map in and out using the pushbuttons. The tactical map also shows SAM threats and kill radii, and waypoint information

Your aircraft's nose is always at the bottom of the screen and pointing upward. As you turn, so does the map.



Symbology

Current aircraft position. The small cross with a tail in the lower third of the MFD represents your aircraft's position. A circle appears around your aircraft and changes size, depending on what map scale you have selected.

Map scale. You can zoom the map scale in and out by pressing the pushbuttons (PB14 to decrease the map range, PB15 to increase it). Available ranges are 10 / 20 / 40 and 80nm.

SAM threats/circles. Surface-to-air missile sites show up as solid circles. A large circle surrounding the SAM threat icon represents the SAM's effective missile range. If you're trying to fly through a field of SAM circles, try to weave in between them to avoid coming into their range.

Waypoints. All visible navigation waypoints appear on the map, but have different symbols:

Green line	Planned flight route
Hollow green circle	Normal waypoint
Solid green circle	Currently selected waypoint
Hollow red triangle	Target waypoint (with targets vital to mission success)
Solid red triangle	Current target waypoint

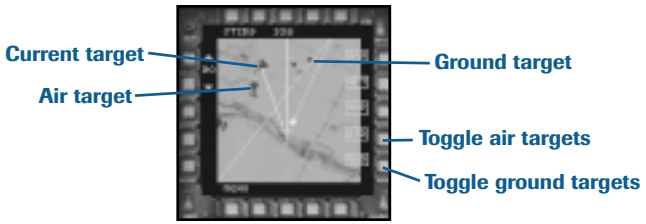
Declutter toggles. You can use PB1 — PB3 to toggle various elements of this display on or off. This is called *decluttering* because it simplifies the display. You can remove SAM sites (PB1), waypoint information (PB2), and the map image (PB3).

Viewing Targets in the JTIDS MFD

In the F-22A, F-117A, and F-15C and F-15E the Joint Tactical Information Distribution System, or JTIDS, replaces the Tactical MFD. The JTIDS gives you a general geographical outline of the terrain, but includes a lot more data from other systems, such as radar, RWR, and AWACS or other flights.

The JTIDS is a large, full-color MFD showing several categories of information. You can toggle the categories on/off by pressing the appropriate push-button. Friendly objects are blue icons, while enemy objects are red icons. In most respects, this display is very similar to the Tactical MFD.

By clicking in the middle of this MFD, you can make it full-screen. Click on it again or press [Z] to restore it to MFD size.



Additional Symbology

The JTIDS uses similar symbology to the Tactical Map Display, with a few exceptions:

Air targets. You can toggle air targets on/off with PB4. Friendly aircraft are blue, and enemy aircraft are red. Locked targets show up as green circles, and are surrounded by a Target Designation (TD) box.

Friendly aircraft appear as blue triangles pointing in the direction of flight. Enemy aircraft show up as red triangles. If the enemy is firing a missile, its icon flashes.

Ground targets. The JTIDS shows all ground targets, not just SAMs. You can toggle ground targets on/off with PB5. Any threat appearing on your RWR also shows up here. Friendly, stationary ground objects appear as blue squares. Friendly, moving ground objects are also blue squares, but they have a "tail" pointing in the direction of movement. Enemy ground object icons are similar, but they're red. If the enemy is firing a missile, its icon flashes. Specified enemy targets show up as solid green squares.

If a SAM has locked onto you, a small red circle appears around it. If the SAM has fired a missile, the circle and the SAM's kill radius circle start flashing.

Current targets. If you lock onto an air or ground target, a yellow line appears. It connects your aircraft to the target, and turns the target 's icon solid yellow. If another aircraft in your flight has a radar lock on a target, the line also appears, but it's dashed.

USING WEAPONS

When selecting weapons, you must first and foremost consider what type of target you're going after, and where you are in your mission. As a general rule, you shouldn't expend any ammo or munitions you need to attack your mission target. (Once you've successfully completed the mission, however, it's fine to hit a few wayward targets on the way home.)

You should always try to select your weapons before you approach the target area — sometimes, even a few seconds saved can afford you a great advantage. A weapon is automatically armed once you select it, and the correct HUD mode is activated.

Weapons with built-in sensors are "fire-and-forget," meaning you don't have to keep the target in view after firing. You can tell which sensor system a weapon uses in the *Loadout* screen. The name of the missile or bomb sensor appears in the weapon description box at the top of the screen. When you move the mouse cursor over a weapon, a general description of that weapon appears in this box.

The following sections discuss factors to consider when you're maneuvering into position and describe how to release each weapon type. For a tactical discussion on combat maneuvers, see **Combat Tactics**, p. 4.56.

Know Your Position

Before using guns, missiles, rockets or bombs, you need to position your aircraft so you can take the best shot possible. Many times, you only have a few seconds to take an opportune shot. You'll find that during combat, you spend a great deal of time trying to get yourself into an advantageous firing position.

When firing guns and missiles against an air target, you want to keep the aspect angle between you and your target small. In other words, you want to have a good, straight shot at a threat.

In an ideal situation, you should be right behind your target — he can't fire on you when you're tailing him. If you're attacking a ground target, where you drop an air-to-ground missile or bomb depends on your speed, altitude, range and weapon type.

This chapter's section on **Combat Tactics**, p. 4.56, describes some basic moves you can use to gain an advantageous firing position.

Know Your Sensors and ECMs

All aircraft come pre-loaded with standard electronic countermeasures (ECMs) and built-in sensors. These accessories help you navigate, acquire targets, and defend yourself against missile attacks.

Chaff and Flares

Countermeasures are a valuable line of defense against surface-to-air missiles and enemy interceptors. They can help you escape a long-range engagement without a dogfight, plow through SAMs flanking a vital enemy target, or ward off undetected IR missiles if it does get down and dirty.

Chaff and flare dispensers are automatically loaded onto your aircraft prior to each mission and cannot be removed. The actual number of chaff and flare units varies with the type of aircraft you're flying, and totals appear in the *Loadout* screen (see **Interface: Loadout Screen**, p. 1.22).

AN/AAQ-13

This is the navigation pod of the Low-Altitude Targeting and Navigation Infra-Red (LANTIRN) system. It gives certain aircraft (the F-16C, F-15E, F-117A, and A-10A) nighttime and low-altitude flight capabilities. You must have this pod loaded if you want to:

- Use the terrain-following radar
- Use the NAVFLIR (navigation FLIR)

AN/AAQ-14

This sensor pod is the targeting pod of the LANTIRN system. It gives you superior nighttime targeting and guidance capabilities. You must have this pod loaded if you want to:

- Use the targeting IR camera to view IR video of your targets
- Use laser-guided weapons (i.e., GBU bombs)
- Use automatic weapon cueing for AGM-65s or GBU-15s

AN/AXQ-14

The AN/AXQ-14 datalink pod is automatically loaded on your aircraft. It allows you to guide a GBU-15 after launch via TV imagery and remote steering.

AN/ALQ-131

This jamming device tries to fool enemy radar systems by sending out large amounts of microwaves. The object of jamming is to disguise the size and location of your aircraft.

Know Your Weapons

Here's a brief overview of weapon categories. For additional information, see other sections of this manual.

- **Interface: Loadout Screen** (p. 1.22) talks about loading specific types of weapons and aircraft loading.
- See the **Weapon Information Chart**, p. 4.32, to reference HUD and MFD mode information.
- **Cockpit: Head-Up Display** (p. 2.12) and the weapon MFD pages (beginning on p. 2.29) describe specific symbology for each weapon type.
- See **Know Your Guidance Systems**, p. 4.34, for details about different guidance methods.
- See **Using Weapons**, p. 4.28, to learn how to use specific types of weapons.

Rockets. Folding Fin Aerial Rockets (FFARs) are unguided weapons requiring visual targeting and good aim. Because they tend to be incendiary (fire-spawning), you can use them at close range if you're not concerned about collateral damage to other vehicles or structures.

Missiles. You have a wide variety of missiles at your disposal — short-range, long-range, air-to-air, air-to-ground, radar-guided, IR-guided and TV-guided. Missiles are best applied against targets from 3 to 80km away. Certain missile types use built-in guidance systems, while others require you to load a sensor pod. Additionally, you can't fire the missile until you've activated the correct systems and modes.

Bombs. The two garden varieties of bombs are guided and unguided. Unguided bombs are cheap, plentiful and highly effective over a wide area, such as an airfield. TV- and laser-guided bombs are best dropped on strategic targets essential to the success of the mission. For instance, you'd probably want to use a guided bomb to hit a communications bunker or air defense radars, but not a column of tanks. Guided bombs require some sort of onboard guidance system.

Useful Keys

Here are some useful keys for activating various weapon functions:

]	Cycle through air-to-air weapons
[	Cycle through air-to-ground weapons
F11	Display missile chase view
M	Cycle through avionics master modes — navigation, air-to-air and air-to-ground. Each master mode selects the correct radar type, weapon type and HUD mode.

Overview: Air-To-Air Weapons

Gun Designations: GAU-, GsH

Missile Designations: AA-, AIM-

Sensor Systems: IR, FLIR, SARH, Active Radar

Guns used to be the only weapon available during an air battle, and dog-fighting used to be a test of a pilot's visual acuity. In modern air combat, however, the majority of battles are fought without opponents ever coming within visual range of one another.

While guns remain useful at extremely close ranges, air-to-air missiles extend air combat by miles. Long-range, air-intercept missiles can effectively target threats as far as 80 miles; short-range air-to-air missiles can be fired from near point-blank range or from up to 25 nautical miles away.

With the exception of mounted guns, air-to-air weapons are guided by either the aircraft's sensors or an independent "seeker" head. But although these advancements make them effective weapons, striking targets with air-to-air missiles still demands good piloting skills and selective firing.

Overview: Air-To-Ground Weapons

Missile Designations: AGM-, HARM

Bomb Designations: GBU-, MK-, CBU-

Rocket Designations: LAU-

Sensor Systems: IR, FLIR, HARM, Laser, Active Radar

Air-to-ground weapons include missiles, rockets, bombs and mounted guns. They come in two basic varieties — unguided and guided. Unguided weapons (such as "iron" bombs) fall along a predictable trajectory. Guided weapons, such as Maverick missiles and laser-guided bombs, use the aircraft's seeker or a built-in seeker to steer toward a target after launch.

Some air-to-ground missiles, such as the IR-homing AGM-65 Maverick or the active radar-guided AGM-88 HARM, are long-range, "standoff" weapons. Once fired, these weapons do not require guidance from the launching aircraft. As such, they are "fire-and forget" weapons — you can launch them and immediately turn toward a new target. During flight, they have the ability to modify their flight path.

Air-to-ground weapons employ the same guidance systems as air-to-air weapons, although some have other sensor types built into the seeker head. The sensor on a HARM weapon homes in on targets emitting radar, while the sensor on a laser weapon homes in on targets pinpointed by a laser beam.

Weapon Information Chart

Weapon. Designation and name of the weapon as they appear on the *Weapon Inventory* screen.

MFD Name. Abbreviation used for the weapon on the Radar MFD pages.

Guidance. Sensor used to guide the weapon to target. Laser- and datalink-guided weapons and SARH use launching aircraft's sensor; all other entries refer to the seeker mounted on the nose of the weapon itself.

Weapon Type. What the weapon is designed to do. (Preferred targets are footnoted when they are not obvious.)

Name	MFD Name	Guidance	Weapon Type
M61A1 Vulcan	M61A1	Unguided	20mm cannon[1]
GAU-8 Avenger	GAU-8	Unguided	30mm cannon[1]
AIM-7F Sparrow	AIM7F	SARH	Medium range anti-air
AIM-7B Sparrow	AIM7B	SARH	Medium-range anti-air
AIM-9D Sidewinder	AIM9D	IR	Short-range anti-air
AIM-9M Sidewinder	AIM9M	IR	Short-range anti-air
AIM-9X Sidewinder	AIM9X	IR	Short–range, anti-air
AIM-120A AMRAAM	AIM120A	Radar	Medium-range anti-air
AGM-45 Shrike	AGM45	Passive Radar	Stand-off precision attack
AGM-62 Walleye	AGM62	TV	Stand-off precision attack
AGM-65B Maverick	AGM65B	IIR	Stand-off precision attack[2]
AGM-65D Maverick	AGM65D	IIR	Stand-off precision attack[3]
AGM-88 HARM	AGM88	Passive radar	Stand-off precision attack[3]
AGM-130	*AGM130*	TV OR IIR	Stand-off precision attack
AGM-142 Popeye	AGM142	TV	Stand-off precision attack
CBU-52	CBU52	Unguided	Anti-personnel/-materiel
CBU-58	CBU58	Unguided	Anti-personnel/-materiel
CBU-87	CBU87	Unguided	Anti-personnel/-materiel
CBU-89	CBU89	Unguided	Anti-armor
CBU-93	CBU93	Unguided	Anti-armor
GBU-10 Paveway I	GBU10	Laser	Precision attack
GBU-12D Paveway II	GBU12D	Laser	Precision attack
GBU-15	GBU15	TV/Datalink	Stand-off precision attack
GBU-24 Paveway III	GBU24	Laser	Precision attack
GBU-27 Paveway III	GBU27	Laser	Precision attack
GBU-30 JDAM	GBU30	TV	Precision attack
Mk 82	MK82	Unguided	Gen. purpose ground attack
Mk 84	MK84	Unguided	Gen. purpose ground attack
Napalm	NAPALM	Unguided	Incendiary ground attack

[1] Aircraft, soft ground targets. [2] Armored vehicles. [3] Hardened targets.

Know Your Modes

All weapons automatically activate a specific HUD and set of MFDs. Symbology for all HUDs and MFDs is detailed in **Chapter 2: Cockpit**. For information on radar modes, see **Using the Radar** , p. 4.12.

HUD Mode Summary

Here is a summary of combat-related HUD modes. For full descriptions, see **Chapter 2: Cockpit**.

Air to Air modes

- **AA LCOS Mode.** Used for firing the internal gun at air targets.
- **AA EEGS Mode.** Used for firing the internal gun at air targets.
- **MRM Mode.** Used for firing medium-range missiles.
- **SRM Mode.** Used for firing short-range missiles.

Air-to-Ground Modes

- **CCIP Mode.** Used to release rockets general-purpose and laser-guided bombs.
- **HARM Mode.** Used to fire HARM missiles (anti-SAM weapons)
- **STRF Mode.** Used for firing the internal gun at ground targets.
- **TV Mode.** Used to launch TV-guided missiles at ground targets.

The chart below gives information about which HUD and MFD modes are associated with each weapon type.

Air-to-Air

Weapon Selected	HUD[1]	MFD 1	MFD 2	MFD 3
MRM missile	AA (MRM)	AA Radar[2]	Tactical/JTIDS[3]	RWR
SRM missile	AA (SRM)	AA Radar	Tactical/JTIDS[3]	RWR
A/A gun/LCOS sight	AA (LCOS)	AA Radar	Tactical/JTIDS[3]	RWR
A/A gun/EEGS sight[3]	AA (EEGS)	AA Radar	Tactical/JTIDS [3]	RWR

Air-to-Ground

Weapon Selected	HUD[1]	MFD 1	MFD 2	MFD 3
GP bomb	AG (CCIP)	AG radar	Stores	Tactical/JTIDS[3]
LGB bomb	AG (CCIP)	AG radar	FLIR	Tactical /JTIDS[3]
TV-guided missile	AG (TV)	AG radar[5]	TV	Tactical /JTIDS[3]
HARM missile	AG (HARM)	AG radar	HARM	Tactical /JTIDS[3]
GPS (JDAM) missile	AG (TV)	AG radar	TV	JTIDS[3]

[1] The HUD mode is listed first, with the submode in parentheses.

[2] Does not appear in the A-10A or F-117A when you select an MRM missile.

[3] The A-10A, F-105D, F-4E, F-117A, and MiG-29 are not equipped with an EEGS gunsight.

[4] In the F-22A, F-117A, F-15C, F-15E and F-16C, the JTIDS MFD replaces the Tactical MFD.

[5] In the F-4E, the TV MFD displays instead.

Know Your Guidance Systems

The simplest of weapons are unguided, such as Folding-Fin Aerial Rockets (FFARs) and iron bombs. Newer weapons — whether they're air-to-air missiles or air-to-ground missiles and bombs — are guided and use radar, laser or infrared tracking to acquire a target. Each guidance system has its own method of acquiring and locking a target. Some weapons are "fire-and-forget" and have guidance systems built into their seeker head. Others require you to keep the target in view until weapon impact.

Although effective, guided weapons are not the "one-shot, one-kill" devices they are often perceived to be. Used improperly, they can perform dismally.

Semi-Active Radar Homing Weapons (SARHs)

Semi-Active Radar Homing weapons (SARHs) use the aircraft's onboard radar system both to acquire and track a target. No special sensor is required, but this air-to-air missile doesn't have built-in radar. You must keep the target locked on radar so the missile can maneuver toward it. If the targeting aircraft breaks its lock — even momentarily — the missile may miss.

SARH missiles can be launched at medium range (usually 15-20nm) but perform poorly at short range. They also don't work well when fired from above the target, as radar reflected from the ground confuses the missile. The most well-known SARH missile — the AIM-7 Sparrow — is notoriously inaccurate.

Active Radar Weapons

Active radar weapons (like the AIM-120) use the aircraft's normal radar system to acquire a target. Upon launch, the missile's guidance system receives coordinates from the aircraft's weapon system. The weapon flies to the designated point and activates its own seeker head, which it then uses to home in on the target. Since the weapon guides itself, the launching aircraft can break away from battle anytime after firing. For this reason, active radar arms are known as "fire-and-forget" weapons.

Infrared-Homing Weapons

Infrared ("heat-seeking") missiles use internal sensors to detect and track heat-emitting objects, such as an airplane's engine exhaust pipe. Compared to radar-guided weapons, infrared-homing missiles have short range — point-blank to 8nm for air-to-air heat-seekers. Once launched, these "fire-and-forget" weapons guide themselves to the target.

The "lock status" of an IR-guided air-to-air missile appears on the HUD — a floating circle represents the missile seeker. An IR-homing missile locks onto your current radar target if it's in missile range. Otherwise, it looks for the first "hot" target to come into view of its missile seeker head. To launch the missile, all you need to do is keep your aircraft's nose pointed toward the target, and fire.

Target lock is also communicated through sound. For air-to-air heat-seekers (such as the AIM-9 series), missile lock is indicated through an audible "growling" sound. The louder the growl, the better the lock.

HARM (Radar-Seeking) Weapons

The AGM-88 HARM and AGM-45 Shrike missiles are High-Speed, Anti-Radiation Missiles that lock onto targets emitting radar transmissions. The HARM seeker is built into the missile's nose and requires no onboard guidance. HARMs are highly effective against radar vehicles, radar-equipped SAMs and ground-based radar installations. A threat's only defense against such a missile is to turn off the radar altogether.

The HARM is a "fire-and-forget" missile. However, if a HARM is launched and the target turns off its radar, the missile continues to the target's last known location and detonates.

Television-Guided (TV) Weapons

TV-guided missiles rely on television imagery to track a target. Each missile seeker head contains a tiny, built-in television camera transmitting electro-optical images to the aircraft's onboard system. TV missiles are equipped with a black/green camera. Two types exist — the self-guiding, contrast homing missile (such as the Maverick series of missiles) and the GBU-series and Popeye manually steered missiles.

As soon as the weapon is armed, the protective dome is removed from the seeker head and imagery from the camera appears in the cockpit's TV MFD. To designate a target, you center the cross hairs in the MFD over the target and fire. Guidance is accomplished by steering the missile remotely.

TV-guided missiles are effective weapon against both soft and hard targets, but are susceptible to fog and other inclement weather conditions.

Global-Positioning System (JDAM) Weapons

The most sophisticated self-guiding missile type in existence is the GPS-guided missile. The Global Positioning System itself is a complex system using satellite data to determine geographical positioning. GPS gives highly accurate information on an object's position and velocity on the Earth's surface and provides worldwide, real-time coverage. In the field of weapons, it provides pinpoint accuracy.

GPS-guided weapons, also referred to as JDAMs, or Joint Direct Attack Munition weapons, are a fairly recent development. These weapons are pre-programmed with the target's GPS coordinates before each mission. GPS missiles (such as the AGM-86B/C) are powered by a turbofan jet engine, which propels the missile at subsonic speeds toward the target coordinates. Using GPS data, the missile flies complicated routes using a terrain contour-matching guidance system. GPS-guided bombs (such as the GBU-30) use the same principle, but are dropped from higher altitudes and carry more payload.

Due to their small size and low-altitude flight capability, GPS weapons are difficult for enemies to detect on radar.

Using Guns

See pp. 2.18-2.20 for symbology for the gun HUDs (LCOS and EEGS).

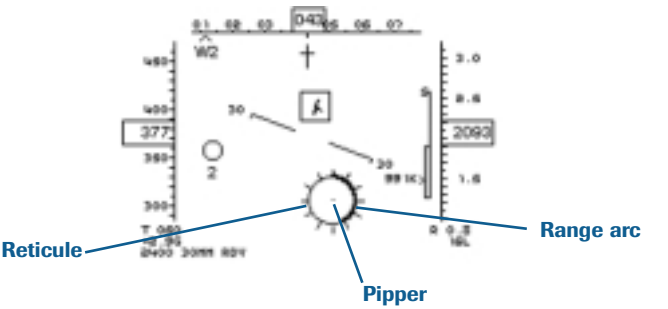
Although missiles are the weapon of choice during most fights, guns remain an essential element of air combat. You don't have to have radar, IR or HARM sensors active to use them, although your radar can help you aim at your target.

Guns have large ammo stores, and are generally most effective only at short range (0-2nm). A single burst of gunfire generally won't kill an aircraft, but it may eliminate a ground target. In general, reserve your guns for close-in combat or low-altitude strafing runs.

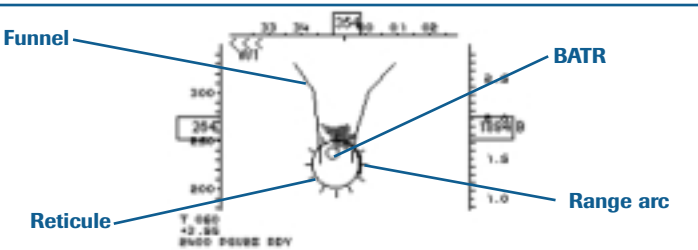
Firing at moving air targets is considerably more difficult. An important aspect of using guns in air combat is calculating how far you need to "lead" the target. The enemy is constantly moving, so you must predict where he's going to be when the bullets reach their mark. You must take into account your enemy's speed and current position and guess how much "lead" in needed to hit him. When your radar is off, you must lead your shots in front of the target to hit it.

When your radar is in air-to-air mode, the LCOS (Lead-Computing Optical Gunsight) displays a pipper on the HUD to help you lead targets. In the F–15C/E, F-22A and F-16C, the Enhanced Envelope Gun Sight (EEGS) replaces the LCOS. Symbology is similar for both sights. Use of the sights is optional — you can always fire guns using Tab. Both of the following sights are AA HUDs that auto-activate when you select your gun.

LCOS GUNSIGHT



EEGS GUNSIGHT



How to Fire Guns

Follow these steps to fire your onboard gun using the pipper gunsight:

1. Select your guns (press [ ] to cycle through air-to-air weapons).
2. Turn on your radar if its not active (press [R]).
3. Press [Enter] to lock onto a target you have within visual range.
4. Center the gun reticule in the HUD over your target.

   The pipper dot inside shows where you should aim to make the target fly into your bullets. Your aircraft's computer calculates the relative speed and distance of your target and makes adjustments to the pipper accordingly.

   A thick line around the perimeter of the reticule measures range from your current position to the target. A shorter arc indicates a better chance of hitting the target, and a longer arc means you have less chance of hitting the target. A full circle indicates a range of about 2nm.
5. Place the gun cross in the center of the pipper, just in front of the target.
6. Follow the target and wait until the arc is small.
7. Fire (press [Tab] or your joystick trigger).

Note: *You can also press [Tab] at any time to fire your guns, even if another weapon is currently active. This is true for both types of gun sights.*

Follow these steps to fire your onboard gun using the funnel gunsight:

1. Select your guns (press [ ] to cycle through air-to-air weapons).
2. Turn on your radar if its not active (press [R]).

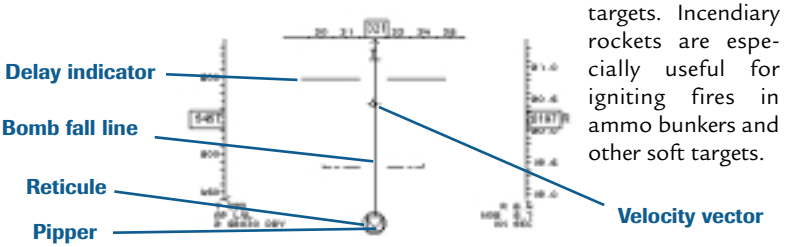
   The EEGS funnel gunsight appears. The two edges of the funnel represent a target with a wingspan of approximately 35ft at different ranges. The wide end of the funnel represents a range of 200 meters, while the narrow end represents 1 nm. To effectively use this sight, you maneuver so the aircraft moves into view between the funnel edges. When you fire the gun, bullets appear to travel down the center of the funnel.
3. Once you have a target within visual range, maneuver so the target falls between the two sides of the funnel. Try to "fit" the aircraft wingtips between the two sides of the funnel. If you can do this, the target is in range.

   Remember, if the aircraft wingspan is as wide as the wide end of the funnel, it's only about 200 feet away. If the wingspan is only as wide as the narrow end of the funnel, the target is 1nm away. It can also fall anywhere in between the two ends of the funnel.
4. Once you have the target in your funnel and it's in range, fire (press [Spacebar] or your joystick trigger).

Using Rockets

See p. 2.26 for symbology — rockets use the same CCIP symbology as unguided bombs.

Rockets are unguided weapons you fire through the use of an LAU-61 launcher. You can ripple-fire rockets (launch more than one at a time) or fire them singly. The launcher consists of a cylindrical housing with launch tubes for 19 Folding-Fin Aerial Rockets (FFARs). Rockets can be used as an air-to-air weapon, though they're generally better-suited for broad use against ground targets. Incendiary rockets are especially useful for igniting fires in ammo bunkers and other soft targets.



How to Fire Rockets

1. Select your rockets (press [to cycle through air-to-ground weapons).
   - When you choose rockets, the HUD automatically enters AG mode and displays CCIP information. This is the same information used to drop unguided bombs.
2. Bring the ground target into your front viewscreen.
3. Maneuver so the CCIP pipper overlays the Target Designation box around the current target in your HUD.
4. Maneuver to position the pipper and reticule over the target.
5. Lower your altitude (unless area is heavily defended) and point the aircraft's nose toward the target.
6. Slightly pitch the plane down so you enter a gentle dive toward the target.
7. Watch the bomb fall line (the line connecting the pipper/reticule to the velocity vector circle). As you get closer to the target, a small horizontal line (delay indicator) "slides" down this line toward the pipper.
8. When the horizontal has almost reached the pipper, fire the rocket(s) (press Spacebar or joystick button 2).
   - When you have the pipper and reticule directly over the target when you fire rockets, you have the best chance of hitting the target.
   - If the target is moving, lead it slightly to ensure a hit.

Using Missiles

Missiles are a fighter's best offense — they're maneuverable, deadly and possess "smart" guidance systems. Guided missiles use a seeker to track targets after launch. The radar, IR or laser seeker identifies the target position and feeds course corrections to the canards (small "wings" on the aft end of the missile). This in-flight maneuverability has given missiles a reputation of being able to take out targets over 100 miles away.

Missile Parameters

Before firing a missile, make sure you consider the following parameters.

Range

Long-range missiles can be fired from as far as 150nm away, while medium or short-range ones have a maximum launch distance around 25nm. As a general rule, however, hit probability increases as the distance to the target decreases.

Most missiles also have minimum launch ranges (usually about 1.5nm) to ensure the launcher doesn't inadvertently harm himself. The missile requires room to get up to speed, and the seeker needs a good lock on the target before it starts maneuvering. Since the probability of a direct hit on a maneuvering target is unlikely, missiles are designed to cause damage over a large radius. Some missiles release a giant, expanding ring of iron bars, while others release hundreds of small metal fragments. The larger the area covered by the warhead, the greater the probability of a kill.

Launch Parameters

In general, you want to launch within the missile's optimal launch parameters. The main factor is range. If you're too close, too far away, or have the wrong target aspect angle (for IR missiles), the missile won't launch.

Watch the Dynamic Launch Zone (DLZ) ladder on the right side of the HUD. This is a small ladder scale indicating your missile's range and the target's current range in relation to your radar's maximum range (see **Medium-Range Missile (MRM) HUD**, p. 2.22).

When the target caret on the DLZ slides within the weapon's kill range line, you can fire.

Missile Maneuverability

Although canards and guidance systems make the missile a fairly maneuverable, long-range weapon, their maximum effect only occurs during the first 10 seconds of flight. This happens because missile engines do not burn for the entire missile flight. The motor engages after launch, rapidly accelerating the missile to top speed using thrust. During this stage, the missile is highly maneuverable. However, once the engine runs out of fuel (5–10 seconds after launch), the missile glides the rest of the way to the target, losing speed as it glides. As speed decays, so does maneuverability.

G-Load Limit

The rail or hardpoint on which the missile is mounted has a maximum G-load limit. When the aircraft turns, climbs or dives suddenly, the rail and missile are stressed because of the incurred G-force. If the G-force is too strong, the missile can't launch properly.

Most missiles can be fired during turns, as long as you have a good target aspect angle. If the force is above the launch maximum (different for all missiles), you'll lose all lock indicators in your HUD. In general, the missile must pull at least 7 times the G-load as the target in order to follow it. If the target is pulling 8G, the missile needs to pull as much as 56G.

Keep this in mind when firing a missile after you enter a turn. A hard maneuver bringing you right onto a bandit's six does little good if you can't fire the missile because you're pulling too many Gs.

Aspect Angle

Target aspect angle plays a large role in missile effectiveness. This refers to the angle between your nose and the targeted aircraft. Low-aspect shots (fired from directly behind or in front of the target) have a greater chance of success than those from high-aspect (fired at the target's side). A good aspect is integral to a missile's success.

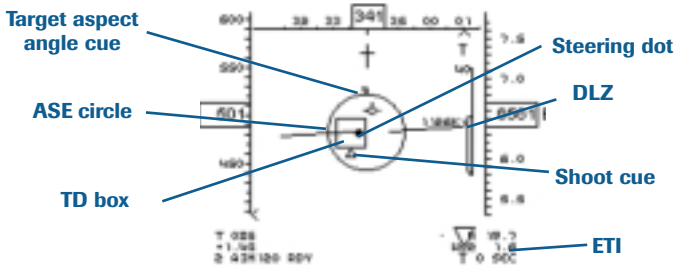
Target aspect also affects missile range. If the target is moving toward the launching aircraft, the missile has less distance to travel. The missile can therefore be fired sooner because the target "flies into" it. This effectively extends the missile's maximum range. Conversely, if the target is moving away from the missile, the missile's effective range is reduced. It must be fired at close range to ensure it has enough energy to travel the additional distance covered by the target after the missile launches.

How to Fire Radar-Guided Missiles

Air-to-air missiles: AA-10

Air intercept missiles: AIM-9D, AIM-7F, AIM-120

*See **Cockpit: Medium-Range Missile (MRM) HUD** , p. 2.22.*



Follow these steps to fire a radar-guided missile:

1. Select AA master mode (M cycles through avionics master modes).
2. Select an MRM missile as your current weapon. (See list above,] cycles through air-to-air weapons.)
3. Turn on your radar if its not active (press R).
4. Long-Range Search (LRS) radar submode is active by default. If you want a different submode, press Q. (See **Air-to-Air Radar Submodes**, p. 4.13.)
5. Once threat icons appear in your Radar MFD or you can see threats, press Enter to lock onto a target. (Some radar submodes automatically lock onto the first target scanned.)

- A TD box marks the locked target on the HUD. A diamond-shaped icon marks the locked target on the Radar MFD.

6. Move within missile range (20nm for medium-to-long range missiles). You'll know you're in range when the caret on the DLZ moves between the minimum and maximum range. If an "X" appears in the ASE circle, you're too close to fire.
7. Maneuver so the steering dot falls inside the ASE circle.

- A triangular shoot cue appears beneath the TD box when your target is within weapon range.

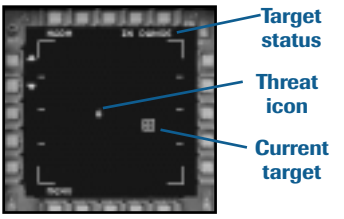
8. Fire (press Spacebar or button 2 on your joystick).

- Active radar missiles, such as the AIM-120, are "fire-and-forget" weapons. You don't have to keep the target in sight — as long as the missile maintains an LOS to the target, it guides itself.
- Semi-Active Radar-Homing (SARH) missiles, such as the AIM-7B/F/M, rely on your aircraft's radar for continued guidance after launch. For these missiles, you must keep your radar lock on the target until the missile impacts. (However, you don't have to keep it in your HUD view.)
- The larger the ASE circle, the better your chance of a hit.

How to Fire Radar-Homing Missiles (HARMs)

Air-to-ground missiles:
AGM-45B, AGM-88

*See **Cockpit: HARM MFD Page**, p. 2.46, and **Cockpit: HARM HUD**, p. 2.27.*



Follow these steps to fire a HARM:

1. Select AG master mode (M cycles through avionics master modes).
2. Select a HARM missile as your current weapon. (See list above; [cycles through air-to-ground weapons.)
   - The HARM MFD automatically displays when a HARM missile is selected.
3. (Optional) Turn on your radar if its not active (press R).
4. The HARM missile automatically locks onto whatever target you currently have locked on radar. If more than one target is spotted, it locks onto the nearest one.

   The current HARM target (which can be different than your radar target if you cycle through targets or left-click on a target in the HARM MFD) appears as a diamond in the HUD.
   - A diamond-shaped TD box marks the locked target on the HUD.
   - You can switch HARM targets. Press Enter or left-click on a threat in the HARM MFD.
   - Your AG radar shows the currently locked (priority) target as a bright target icon in the Radar MFD with cross hairs on top of it. Steer toward the target to bring it into view.
   - Each type of ground threat has a specific icon (shown in chart to the right). The icon for the currently locked threat is boxed.

Threat Type	Icon
SA-2	2
SA-3	3
SA-5	5
SA-6	6
SA-8	8
SA-10	10
Hawk	H
ZSU-23X4	G
Roland	R
General AAA	A

5. Move within the HARM missile's range (30nm). You'll know you're in range when IN RANGE appears in the HARM MFD.

   NO RANGE Missile has a lock, but target is out of weapon's range

   IN RANGE Missile has a lock, and target is in range; ready to fire
6. Fire (press Spacebar or button 2 on your joystick). After launch, the HARM missile guides itself to the target by homing in on radar emissions coming from the target.

How to Fire IR-Guided Missiles

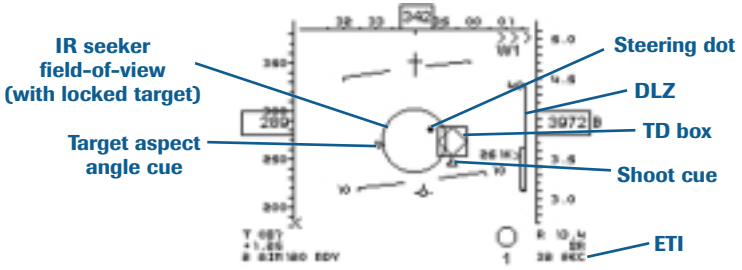
Air-to-air missiles: AA-2D, AA-8, AA-11

Air intercept missiles: AIM-9D, AIM-9M, AIM-9L

*For SRM symbology, **Short Range Missile (SRM) HUD**, p . 2.24.*

Follow these steps to fire an infrared-guided missile:

1. Select AA master mode (M cycles through avionics master modes).
2. Select a SRM missile as your current weapon. (See list above,] cycles through air-to-air weapons.)
3. Turn on your radar if its not active (press R).



4. To acquire a target, look for a threat icon on your radar and lock onto it (press Enter). Then, move within missile range (6nm for SRMs).
   - An IR missile automatically acquires a target you have locked on radar. When launched, it will track that threat.
   - The large circle represents the IR missile's seeker head. It's large when no target is locked, but shrinks in size when you acquire a lock.
   - You do not have to gain a radar lock on a target to fire an IR missile. If you don't designate a radar target, the missile locks onto the first target that enters its seeker head view. However, you must be close enough to the target so the missile can acquire its own lock.
   - You'll know you're in range when you hear the missile tone changes. You can also watch the DLZ ladder on the right side of the HUD (see p. 2.23 for details on the DLZ).
4. Watch the TD box. When you're within launch parameters, a small triangular shoot cue appears beneath the TD box.
5. Fire (press Spacebar or button 2 on your joystick).
   - All IR-guided missiles track "hot" objects. You don't need to keep an IR-guided missile in view after you fire it.

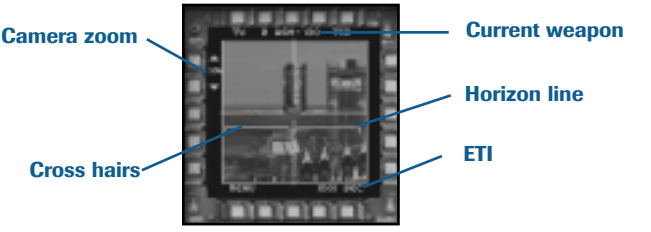
How to Fire TV-Guided Missiles

Air-to-ground missiles: AGM-62, AGM-65B, AGM-65D, AGM-130

*See **Cockpit:TV-Guided Missile (TV) HUD**, p. 2.28, and **Cockpit: TV MFD Page**, p. 2.44.*

Follow these steps to fire a TV-guided missile:

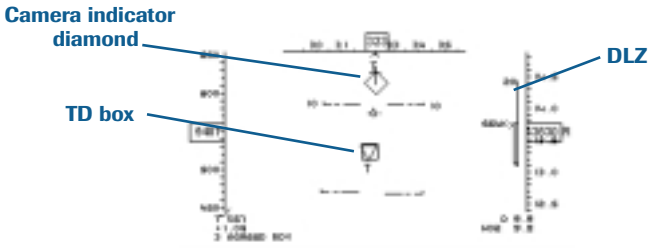
1. Select AG master mode (M cycles through avionics master modes).
2. Select a TV-guided missile as your current weapon. (See list above, [cycles through air-to-ground weapons.)
   - The TV MFD automatically displays when a TV missile is selected.
3. Turn on your radar if its not active (press R).
4. Look for a threat icon on your radar and acquire a lock on it (press Enter).
   - The TV MFD automatically slaves to the current radar target. If you don't have a target selected, the missile camera points at the horizon. For AGM-65D missiles, however, the LANTIRN pod constantly scans underneath the gate for "hot" (high-contrast) targets. When the gate moves over a hot object, it automatically locks onto it. The FLIR camera view centers on this contrast lock, which is marked by a bright white square on HUD. Panning the camera breaks this lock.
   - In the TV MFD, a television image displays of the contrast-locked target with a cross hair over it.



- Press Z to remove the cockpit and toggle a full-screen view of the MFD missile information. Press it again to return to HUD view. It's a good idea to engage level autopilot (press A once) before you do this.
- You can pan the camera by pressing Ctrl and ←→↑↓ (as described below). Press PB14 or PB15 to zoom in/out.

***Note:** The AGM-62 and AGM-130 (and the GBU-15, a TV-guided bomb) can be panned after launch. The AGM-65 can only be panned before launch.*

For all TV-guided weapons — panning the camera while you have a radar lock on a target breaks that radar lock.



4. Move within the TV-missile's range (approx.12nm). You'll know you're in range when the small caret on the DLZ ladder falls within your weapon's kill zone. (See p. 2.23 for details on the Dynamic Launch Zone indicator.)

   - You can view the current target in the TV MFD. Wait to fire, however, until you can plainly make out your target. (Press PB14 or PB15 to cycle through the camera's zoom levels.)
   - To maintain a radar lock, you must keep the target within sight of the seeker head: 30° left or right, 15° up and 45° down of the camera's nose. If you move the camera, it breaks the lock. After launch, however, the camera is pointed toward the target, and you can fly your aircraft in any direction.
   - If you see "NO SOURCE" in the TV MFD, you're out of TV missiles.

5. Press Spacebar or joystick button 2 to release the weapon.

   - After release, the Maverick is self-guiding. You don't need to keep flying toward its target, or keep the target in view.
   - You can manually steer an AGM-62 or AGM-130 to its target *after* launch. Press and hold Ctrl and then use ←→↑↓. Press PB14 or PB15 to zoom in/out.

It often helps to place your aircraft in LVL autopilot mode first.

Note: *The GBU-15 series of TV-guided bombs can also be steered to some extent after launch (they are un-powered weapons, so steering changes can only be slight). See* ***How to Drop TV-Guided Bombs****, p. 4.49 and* ***Cockpit: TV MFD Page****, p. 2.44.*

Using Bombs

Bombs are short-range weapons relying on gravity for "propulsion." Most are fitted with short fins or canards to help keep the bomb aligned nosefirst.

Conventional bombs have a range of only 1 to 2 nautical miles, have no supportive guidance systems, and have non-adjustable tail fins. More modern versions have seekers and aircraft guidance systems that make small card adjustments during glide flight — still, their range is no greater than that of iron bombs.

Dropping bombs in not an easy task — you must figure the correct drop point based on a combination of altitude, airspeed and pitch of the aircraft. The higher you are when you drop the bomb, the further the bomb can travel (in ground miles). This is true because the bomb travels both down and forward when dropped — the longer it's in the air, the longer range it has.

Accurately dropping a bomb takes a lot of guesswork and can often be dangerous because of the close range required. Generally, a bomb has a range of about 1nm per every 1000 feet of aircraft altitude. (But, if dropped from too far away, the bomb may miss altogether.)

How to Drop Unguided Bombs

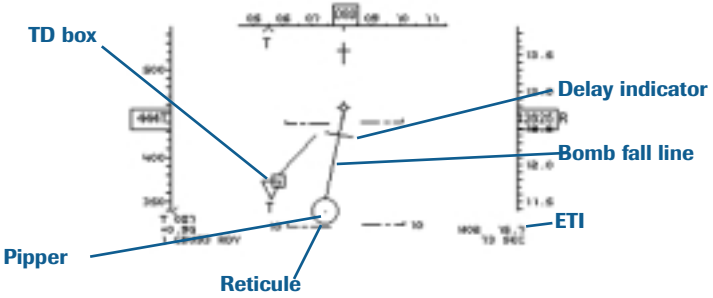
General-purpose bombs: MK-82, MK-83, MK-84

Cluster bombs: CBU-24, CBU-52, CBU-58, CBU-87, CBU-89, MK-20

*See **Continuously Calculated Impact Point (CCIP) HUD**, p. 2.26.*

Follow these steps to drop an unguided bomb:

1. Select AG master mode (M cycles through avionics master modes).
2. Select an unguided bomb as your current weapon. (See list above, [cycles through air-to-ground weapons.)
3. Attain the appropriate altitude. This varies according to air defense in the area — fly at 5000ft for lightly guarded areas, 10,000ft or higher for defended areas).
4. Fly within several miles of the intended target (approximately 1nm for each 1000ft of altitude).
5. Bring the ground target into view.
6. Maneuver to place the CCIP pipper over the TD box around the current target in your HUD.
7. Watch the HUD — it automatically enters AG mode and displays CCIP information when you select an unguided bomb as the current weapon.
   - Try using the full-screen view (F1) when dropping bombs in CCIP mode.
9. Maneuver so that the circle onscreen (pipper/reticule) is over the target.



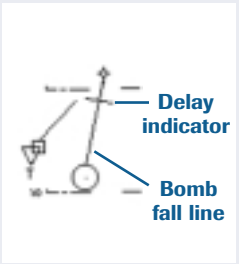
10. Lower your altitude (unless area is heavily defended), but not too much.
11. Watch the bomb fall line (the line connecting the pipper/reticule to the velocity vector circle). As you get closer to the target, a small horizontal line (delay indicator) "slides" down this line toward the pipper.
12. When the horizontal has almost reached the pipper, release the bomb (press Spacebar or joystick button 2).

- When you have the pipper and reticule directly over the target when you release the bomb, you have the best chance of hitting the target.
- If you selected a ripple setting in the Stores MFD, the pipper marks the middle of all of the weapons' impact points.
- Practice dropping unguided bombs, in Weapon School (see p. 1.8).
- If you elected to ripple-fire your weapons, all of the cues flash as soon as the first bomb drops, and continue until the last weapon releases.

Delayed CCIP delivery

If the bomb's impact point can't be shown on the HUD due to high altitude, shallow dive angle, low speed, or high angle of attack, the HUD switches to *delayed CCIP mode*. In this mode, you still release the bomb when the pipper is over the target, but the drop is delayed. The HUD displays a delay indicator on the bomb fall line.

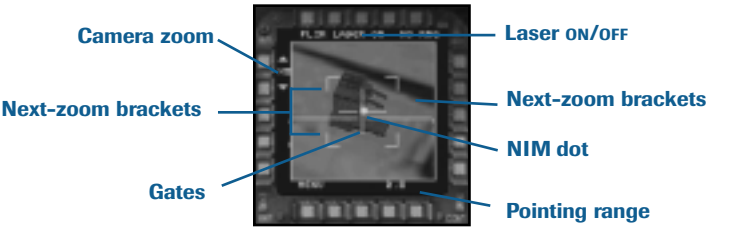
1. When you press the pickle button, keep it depressed. The delay indicator is on the bomb fall line, but the bomb doesn't release.
2. As range to target decreases and the bomb is within 10 seconds of releasing, the line starts sliding down the bomb fall line. Once the delay line crosses the velocity vector, your bombs drop.
3. Once the bomb fall line quits flashing, release the pickle button.



How to Drop Laser-Guided Bombs

Laser-guided bombs: GBU-10, GBU-12, GBU-24

*See **FLIR MFD**, p. 2.42.*



Follow these steps to drop a laser-guided bomb:

1. Select AG master mode ([M] cycles through avionics master modes).
2. Select a laser-guided bomb as your current weapon. (See list above, [ ] cycles through air-to-ground weapons.)
   - The FLIR MFD automatically appears when you select a laser-guided weapon.
4. Attain the appropriate altitude. This varies according to air defense in the area — but 15,000ft or higher is good for defended areas.
5. Turn on your radar if it's not active (press [R]).
6. Fly within 15 miles of the intended target.
7. Lock onto a target. To cycle through available targets, press [Enter]. To cycle through contrast targets in FLIR (LANTIRN) MFD, press [Ctrl][Enter].
   - The LANTIRN pod is automatically loaded for all aircraft carrying laser-guided bombs except for the F-4E. For this aircraft, you need to load the LANTIRN pod in order to use Paveway laser-guided bombs.

This HUD icon indicates where the FLIR camera and the laser designator are currently pointed.

9. Toggle the laser on (press [L] or click PB18).
10. Initiate a gentle dive or level bomb approach directly toward your target.
11. Watch the FLIR MFD — keep the bright green dot within the gates — this keeps the target in the bomb's view.
    - To adjust the dot's position, you can slightly steer the laser designator by pressing [Ctrl] and [←][→][↑][↓].

12. Fly to the target and drop the bomb (press Spacebar or joystick button 2).
    - The CCIP reticule on the HUD should be over the TD box when you release.
    - For the laser-guided bomb to maintain a lock, the target must stay within ±80° left and right and ±60° up and down of the camera's center.
    - The FLIR image can be zoomed to 2X, 4X and 8X magnifications. (Press PB14 and PB 15 to increase and decrease the zoom level.)
    - You can instruct one of your wingmen to laser-designate a target that you've spotted on your radar. Press Enter to cycle through to the target you want to hit, then press Alt L or Alt Shift L to have your wingman designate that target. You won't be able to control the LANTIRN's FLIR camera, however, since it's on another aircraft.

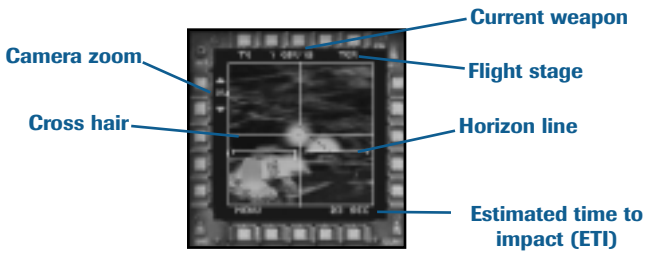
How to Drop TV-Guided Bombs

TV-guided bombs: GBU-15

You drop a TV-guided bomb just as you do as TV-guided missile. See **How to Fire TV-Guided Missiles**, p. 4.44.

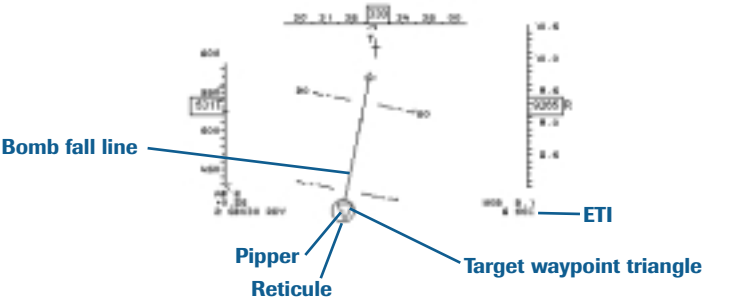
*See **TV MFD Page**, p. 2.44, for more details.*

- The GBU-15 automatically enters transitional (TRANS) launch profile after launch.
- You can correct the yaw of the weapon (i.e., its heading) somewhat by pressing Ctrl and ←→.
- Twenty seconds before impact, the weapon enters terminal (TERM) loft profile. You can still make pitch and yaw adjustments until impact.
- The TV image can be zoomed to 2X, 4X and 8X magnifications. (Press PB14 and PB 15 to increase and decrease the zoom level.)



How to Drop GPS-Guided (JDAM) Bombs

GPS-guided bombs: GBU-30



Follow these steps to drop a GPS-guided bomb:

1. Prior to flight, note the target waypoint at which you must drop the GBU-30. A GPS-guided bomb is preprogrammed to hit at a certain set of coordinates. If you drop it over the correct target waypoint, it can make slight corrections in-flight so that it detonates at the pre-specified coordinates.
2. As you approach this waypoint during flight, select the GBU-30 as your current weapon. (Press [to cycle through air-to-ground weapons.)
3. Attain the appropriate altitude. This varies according to air defense in the area — but 15,000ft or higher is good for defended areas.
4. Turn on your radar if it's not active (press R).
5. Activate air-to-ground radar mode (press R to toggle between air-to-air/air-to-ground radar).
6. Fly within 15 miles of the intended target.
7. Gently nose down and fly toward the target specified in your briefing.
8. Place the reticule/pipper on the HUD over the triangle representing your current target waypoint.
9. Drop the bomb (press Spacebar or joystick button 2).

DEFENSES AND COUNTERMEASURES

Attacking the enemy is only half the job — surviving the mission is the other half. Your aircraft carries various defensive systems called *countermeasures*, designed to protect you and your aircraft. They may be electronic (jamming) or physical (chaff and flares).

Radar Cross-Section (RCS) Signatures

Before you can effectively evade missiles, you need to understand how they track your aircraft. Every aircraft has a set of "signatures" that give away your presence to radar and infrared sensors. This radar or infrared signature represents your aircraft's radar cross-section, which indicates how "big" your aircraft is on enemy radars.

Your aircraft's configuration can modify signature values. For example, using afterburners creates hot exhaust ports and increases your *IR signature* to 200%, making you twice as detectable as normal. Carrying external stores increases your *radar signature* by 33%, making you one-third more detectable than a "clean" aircraft. Likewise, lowering your landing gear increases radar signature by 25%.

Radar jamming with electronic countermeasures (ECM) reduces the chances of being tracked by radar sources, but drastically increases your chances of being detected by an enemy RWR because of the added emissions (see **How Jamming Works**, p. 4.53). This should be your first defense against enemy radar systems.

Pointing your aircraft toward a sensor also greatly reduces the signature. This is because the radar cross-section of your aircraft (amount of surface area visible to radar) appears smaller when it's viewed from the front. Conversely, a full side or top-down view gives a large cross-section.

Note: *To help reduce your aircraft's radar signature in the game, place your radar on standby by pressing* Shift R. *It won't emit radar, and you'll be less detectable.*

Avoiding Detection

Half of any battle is arriving at the target area unspotted. The ingress phase of a mission is often the phase in which you are most vulnerable. You are heavily loaded with both weapons and fuel, so it is harder for you to maneuver.

Stay High During Cruise Flight

The higher you are, the more advantage you have against another enemy aircraft. You consume less fuel at higher altitudes as well since the air is thinner. Enemy aircraft also have a harder time spotting you against the sun during daytime missions.

Stay Low During Ground Missions

In aircraft such as the F-15E, flying at extremely low altitudes is the best way to remain hidden. Flying below 500ft puts you below the minimum detection altitude for most ground radar systems. Flying nap-of-the-earth (NOE), or hugging terrain contours, decreases the chance you'll be detected by aircraft by making it difficult for radar to pinpoint and track your location among the "ground clutter."

If you're flying NOE, make sure you're seeing an above ground level (AGL) altitude measurement, and not above sea level (ASL). The altitude mode changes when you change master modes. If you're in AG mode, you should be fine.

Use Your Radar Sparingly

Because most enemy aircraft and many ground objects are equipped with radar-warning receivers (RWRs), they're able to detect your radar emissions. When you are using your radar, you become instantly more visible to enemy ground and aircraft detection systems. While their radar systems normally rely on their own emissions bouncing off your aircraft in order to locate you, if your own radar is active you are broadcasting emissions for *them*. Limiting radar emission by not leaving your radar active all of the time can help you remain undetected.

Your radar continues to emit, even when both the A/A and A/G Radar pages are not visible. To prevent your radar from emitting, you must manually disable it by pressing Shift R.

Using Defensive Systems

Missiles may be highly maneuverable but they have their limits. Your best defense is to remain outside the enemy missile's range. Failing that, using ECM at moderate to long ranges may confuse enemy radarscopes and prevent enemies from firing at you. ECM measure have no effect against heat-seeking missiles and have unpredictable results against radar-homing missiles fired at close range. Under these conditions, you must rely on maneuvering and chaff or flares to defeat the missile.

Initiate Jamming

You can equip your aircraft with an AN/ALQ-131 jamming device in the *Loadout* screen (p. 1.22). By default, your radar warning receiver (RWR) remains active at all times. Jamming isn't available on aircraft that do not have an RWR. Since RWRs also detect jamming signals, never use jamming when you still have the element of surprise. Once you're spotted, use it freely.

- [U] Display RWR MFD (not available in all aircraft)
- [J] Activate jamming

How Jamming Works

Electronic Countermeasures, or ECMs, try to deceive enemy radar by emitting large amounts of electromagnetic energy in the form of microwaves. Jammers have several different operating modes, including noise, pulse, continuous-wave, transponder and repeater. Part of the radar warning receiver's job is to direct the intensity, frequency and direction of the jamming transmission.

These jamming signals reflect false radar returns to the radar source. The radarscope at the point of origination sees both the real radar return, and also the "fake" ones generated by the jammers. The idea is to either make large targets look small, or make small targets look large. Even though the radar can determine the presence of an aircraft and its direction, the false reflections distort the aircraft's true location. Jamming announces your presence to the enemy, but it hides your exact position from them. Jamming in USAF aircraft is accomplished via the ALQ-131 jamming device.

Warning Tones

The radar warning receiver detects incoming radar emissions and warns you when you're being tracked by a guided missile. Two audible tones support the RWR: one for locks, and another for incoming missiles. The first tone is a short blip (called the "New Guy" tone). It sounds when a new threat locks onto your aircraft. The second tone is the missile launch tone, which sounds when any type of missile is launched at your aircraft.

Chaff

With careful use, chaff attracts inbound missiles away from your aircraft. To use chaff, activate your radar-warning receiver. Whenever enemy fires a missile at you, the RWR will sound an incoming missile tone. This indicates you need to drop chaff.

Ins Drop single chaff pod

How Chaff Works

The oldest trick in the book for confusing radar threats is the chaff dispenser, which releases a cloud of small, metallic strips. Chaff distorts incoming radar beams and often attracts missiles seeking out the targeted craft. It is compacted in small cartridges call *pods*, which are released at the command of a button. The filaments or strips inside each pod are made of Mylar film or fine glass fibers covered with metallic particles of aluminum or zinc. Cut to match the wavelength of the expected radar emitter (or a multiple of it), they act as two-ended rods (dipoles) and efficiently deflect radiation.

Radar beams operate on different frequencies, a characteristic that has spawned the development of a "smart" chaff system which can interface with a fighter's sensors. The onboard computer relays wavelength information to the dispenser. The dispenser then cuts the chaff filaments to an appropriate length (usually from 1/4-inch to 1-inch long) to best reflect the frequency of the currently tracking radar beam. Hopefully, the material reflects more radar energy than your aircraft, thus providing a "brighter" target for the missile's seeker.

Flares

Flares are designed to lure heat-guided (IR) missiles away from your aircraft's hot engines and toward the hotter flare. If your aircraft is equipped with a radar-warning receiver (RWR), a tone will sound when a missile is launched against your aircraft.

U Display Radar Warning Receiver (RWR) MFD page

Del Drop single flare

How Flares Work

While chaff cartridges are released to attract radar-seeking missiles, flares are fired to decoy infrared homing missiles. Heat-sensitive missiles head for the hottest spot in the vicinity, namely an aircraft's exhaust pipes and engines. Flares take advantage of this trait by exploding into hot, bright fireballs designed to create an intense burst of heat between the missile and the plane. This sometimes diverts infrared missiles away from the airplane. If the burst is correctly positioned and timed, the missile turns toward the flare and misses its target.

Beating Radar-Guided Missiles

Your RWR sounds a tone to indicate that a missile is tracking you. With a combination of chaff and quick maneuvering, you can shake the missile:

1. If the missile is still far away, turn so the missile is approaching your aircraft from the side. This forces the missile to continually turn to track you and burns up its fuel supply. (At close-range, you probably can't avoid being hit.)
2. Keep the missile off your wing using low-G turns (turns under 2-3G).
3. When the missile closes within 10,000 feet, execute a maximum-G break turn *toward* the missile. At the same time, rapidly release 3 or 4 chaff pods (press Ins three or four times). Ideally, the missile momentarily targets the chaff cloud as your turn moves you outside the missile's field of view.
4. Use alternate views (such as the F5 window) to watch the missile's smoke trail. When the missile loses its lock, it stops pointing at you. If it doesn't seem to be following you, you've fooled it. If you can't tell, listen for your warning horn. It sounds at a fast pace as long as the missile is tracking you.

Beating Heat-Seeking Missiles

The same procedure for radar-guided missiles holds true for heat-seeking missiles, except you fire off flares (press Del three or four times) instead of chaff cartridges.

Heat-seeking missiles work best if they have an unobstructed view of your aircraft's exhaust port. When you execute a break turn, you move out of view and hide your exhaust pipe from the missile's seeker. Shutting off your afterburners and dropping flares is the most effective way to shake a heat missile. With any luck, flares may lead the IR missile away from your aircraft.

Jinking

When you've got a bandit on your tail or at very close range, he'll likely use both missiles and guns. Use the previous tactics to distract the missiles, and jinking to evade guns.

"Jinking" refers to making numerous, erratic flight movements. They key to evading enemy gunfire is being quick and unpredictable. Since bullets are unguided, your enemy has to guess where your aircraft will be at any given time after he fires. For this reason, unpredictably changing course is your best defense.

COMBAT TACTICS

Situational Awareness

In the middle of a fight, you must constantly remain aware of what's going on around you. The radar controller constantly updates you on incoming contacts with bearing and range information. He may also give you short target descriptions such as heading, identification, and ROE.

Visual Cues

You've got many views to help you keep apprised of the battle situation. The function key views (F3 through F12) can help you determine the direction of a long-range target or examine the destruction you've left behind. For visual-range combat, you can also use the view keys on the Numpad to keep track of your enemy.

Here are a few of the most important view keys. For a complete list, see the printed *Reference Card* or see **Cockpit: Cockpit View Controls**, p. 2.48.

F3 **Padlock Target View.** Interior cockpit view that points your "eyes" directly at the currently locked target. Even if the target isn't in your HUD view, this view still looks in the direction of the target.

F4 **Target View.** External view of your current target.

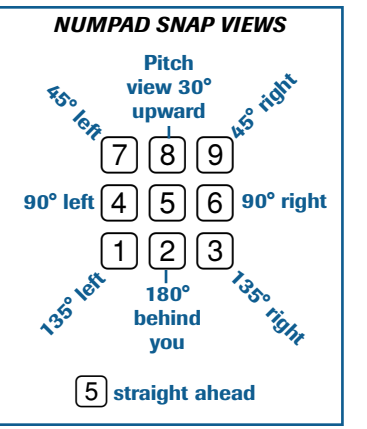
F5 **Player–Threat View.** External view of your aircraft that lines the camera up with your aircraft and the closest inbound missile. If no missiles are present, it chooses the closest threat instead.

Pressing F5 twice padlocks the view to the threat.

F7 **Player — Target View.** External view of your aircraft that lines the camera up with the current target. Press again to reverse the view.

F8 **Arcade View.** External view "chase view" that displays HUD and MFDs.

F11 **Missile — Target View.** External view of your missile as it approaches the target.



Combat Geometry

Geometry plays a large role in air combat. To develop a complete understanding of air combat, you need to know a few geometrical concepts: *angle-off-tail, aspect angle, closure speed, turn rate/radius* and *corner speed*. All describe the differences in position, speed and flight path between your aircraft and an air target.

Aspect Angle

Angle-Off-Tail (AoT) is the angle between your flight path and the flight path of your opponent. If your AoT is low, your flight path is nearly parallel to your opponent's. If it is high, your flight path is nearly perpendicular to the opponent's.

At low AoT, you are either headed directly at an opponent's tail, it is headed directly at your tail or you are facing each other head-on. In each case, your weapons and/or his weapons have a direct line of fire. Almost all weapons perform better when fired at low AoT.

As AoT increases, your opponent flies more perpendicularly to your flight path. Your missiles have to turn more to track their target, and you must "lead" the target more when you're using guns.

During a sustained engagement, your goal is to reduce AoT as much as possible before firing. This usually involves turning to align your flight path with that of the target.

Cone of Vulnerability

When you're within range of an enemy's weapons, you're inside the cone of vulnerability. If an attacker has closed to 1500 meters (about 4500ft), you're vulnerable to his gunfire at any AoT less than 45°. As he moves closer in range, the cone of vulnerability narrows (because the missiles can't maneuver as sharply in short range, and you fall within his lethal cone of fire at any AoT less than 30°. You can use break turns to keep outside the cone of vulnerability.

Closure Rate/Speed

Closure describes your aircraft's speed relative to the speed of your target. A positive closure means the target is approaching you; a negative closure means it is moving away. The larger the number, the faster the range is changing. A closure of -700 knots means the target is moving away from you very quickly while a closure of +70 knots means the target is moving toward you slowly.

Closure also impacts weapon performance. At a high positive closure rate, the range to the target is rapidly decreasing. A missile doesn't have as far to fly, since the target reduces range by flying into the missile. As a result, you can sometimes fire a missile at an approaching target outside your missile range — the target will fly into range in time for the missile to track it. If the closure rate is high and negative, the target is moving away and the missile must fly farther to overtake it.

Pursuit Curves

In close-range fighting, your primary aim is to gain a better aspect angle (firing position) than your opponent. Once you have this advantage, you can tail the enemy using three types of pursuit — lead, lag and pure. Depending on the situation, you may find all three necessary.

Lead Pursuit

To initiate lead pursuit, bank your aircraft so your nose is headed for a point just ahead of your opponent's nose. (Keep in mind tighter turns bleed off kinetic energy — continually turning causes you to lose speed.)

As its name implies, lead pursuit refers to predicting the flight path of a target. You guess where the threat will be in the immediate future, and then point your nose at that predicted position. By redirecting your flight path so it crosses the target's flight path, you stand a better chance of striking the enemy with your weapons. Of course, the trick is to accurately predict where your opponent is going to go.

If you're in the aircraft with the smaller turn radius, lead pursuit tactics can give you a continuing advantage. By making sharper turns than your opponent, you cut across his flight path. This, in turn, reduces your target aspect angle, brings you closer to your opponent, and increases your closure rate.

A danger of lead pursuit is that it can cause the target to disappear beneath your aircraft's nose. If the target makes this erratic maneuver, you may not see it. Keep your turns small but persistent and you'll keep the target in sight.

Lag Pursuit

To execute lag pursuit, pull back on the stick until the target aircraft is positioned just above the flight path indicator in your HUD. Then, ease up slightly on the stick to maintain the enemy's position in your HUD.

Lag pursuit is the exact opposite of lead pursuit. Instead of making a tight turn in the direction your opponent is headed, you use a "softer" turn with a larger radius to follow a point just behind the tail of the enemy aircraft.

Pure Pursuit

Pure pursuit is a direct chase — simply point your aircraft directly at the target and follow its maneuvers as closely as possible. Pure pursuit is most useful when firing weapons at close range, where you can place your sight directly over the target and fire.

Speed vs. Altitude

The energy elements of speed and altitude are the core components of aerial combat. Altitude is a measurement of the aircraft's potential energy, which can be converted to speed by diving. Speed is a measure of an aircraft's kinetic energy, which can be turned into altitude by climbing. Think of kinetic energy as energy in motion, and potential energy as energy in reserve.

At any given instant, an aircraft possesses both a certain amount of kinetic energy (speed) and a certain amount of potential energy (altitude). This energy translates directly into maneuverability. Air Combat Maneuvering, or ACM, is a game of managing energy to maximize maneuverability and defeat the enemy. Finding the balance between speed and altitude requires skill and timing.

Several in-flight controls adjust speed and altitude:

- [S] Your air brakes can slow you down if you're approaching a target too quickly. This helps prevent overshooting.
- [7], [8] Afterburners can be a lifesaver during escape maneuvers, for increasing airspeed or altitude. However, your fuel consumption and heat signature more than double during the burn.
- [F] Flaps provide extra lift during low-speed turns (under 300 knots).

Exchanging Energy

Potential and kinetic energy are exchangeable. An aircraft at high altitude and low speed has lots of potential energy, but little kinetic energy. By diving, the aircraft can convert its altitude into speed and increase its kinetic energy. Similarly, the aircraft can convert some kinetic energy back to potential energy by climbing. The aircraft slows down, but its altitude increases.

A cardinal rule of air combat is that an aircraft with energy has maneuvering options, while an aircraft without energy becomes a target. Maneuvering uses energy, and every unnecessary maneuver you make "burns" kinetic energy. When it's gone, you can't easily get it back.

Because you want maximum maneuverability from your aircraft at all times, you must ration your energy use, always maintaining a sufficient supply for whatever maneuver you might execute. For example, don't go into a high-G turn if you can accomplish the same task with a lower-G turn. Before expending energy, determine whether what you get in return (such as a shot opportunity) is worth the loss of energy.

You can take one of two approaches when you find yourself in a combat situation — you can choose the energy fight or the turn fight. Which one you choose depends on your skill and your aircraft's capabilities.

Choosing Your Attack

Unarguably, the first few seconds of a fight are the most important and can often determine the outcome. Most dogfights last less than one minute, meaning whoever gains the initial advantage usually wins. Every fight is different, and an aircraft designed for turn fighting may find itself better suited for an energy flight. How do you decide which to use?

First, estimate your turn performance versus your opponent's. Maintaining your corner speed (the optimal balance between turn rate and airspeed) means nothing if the bandit can out-maneuver your best turn.

Second, estimate your energy status. If you enter a fight 200 or 300 knots above your corner speed, don't waste all your energy and decelerate to achieve your aircraft's corner speed. Instead, initiate an energy fight and make use of your power. A well-flown energy fight is difficult to beat, as proven in Vietnam by F-4 pilots flying against MiG-17 and MiG-21 opponents.

The Energy Fight

In an energy fight, you take advantage of your aircraft's superior speed and avoid unnecessary turning. Ideally, you want to start the fight in an advantageous position, such as directly behind the bandit in his 6 o'clock low blind spot. Most of the time, however, that's not an option. You must rely on your energy advantage and skills to overcome your adversary.

Initiating the Energy Fight

When you choose the energy fight, you basically concede turn performance to the enemy and rely instead on speed. You must keep your airspeed extremely high, minimizing the distance between you and your enemy's aircraft as you make a series of head-on attacks. The idea is to strike, then outrun your opponent's weapon range (not too difficult if the bandit has only guns or heat-seeking missiles).

While the bandit busily executes a high-G turn to enter the fight, you (as the energy fighter) zoom away in a spiraling dive or climb. Eventually, you can execute a wide turn (to conserve airspeed) and make another offensive pass.

If you execute the initial turn correctly, you'll remain outside your enemy's weapon envelope (range at which his weapons are effective) for nearly the entire fight. You choose when and where to engage, always bringing the fight on your terms. Thanks to your speed surplus, you can enter and exit the fight almost at will.

The energy fight requires discipline, though. One speed-bleeding turn, and you immediately lose your advantage.

The Turning Fight

Your second choice in combat is to enter a maneuvering fight and rely on your turn performance to win the day. The idea behind a turning fight is to reduce the amount of room in which the enemy can make a turn. You accomplish this during the merge (head-on pass) by minimizing lateral separation, or the horizontal distance separating your aircraft from your enemy's.

The merge, or meeting the bandit had on, generally leads to one of two types of turning fights: one-circle or two-circle. You should choose a two-circle fight when you're flying a more maneuverable aircraft than your enemy. Use a one-circle fight if you have all-aspect missiles (or if you believe the enemy doesn't have them).

Two-Circle Fights

Two circle fights, also called nose-to-tail fights, commence when you and your enemy meet head-on. After you pass each other (known as the merge), you both loop around in opposite directions, trying to get on each other's tail. The distance between your flight path is turning room that both of you use. In other words, the turn radii of your aircraft overlap.

Two-circle fights rely more on turn rate than turn radius. You create only enough lateral separation at the merge point to allow for your full turn radius, and then rely on a superior turn rate to bring your nose back to bear on the threat. Two-circle fights keep your target in view at all times and tend to increase the lateral separation between the two aircraft.

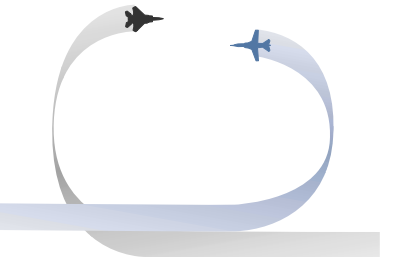
In two-circle fights, always attempt to minimize lateral separation. If the enemy aircraft has substantially worse turn performance than you, don't give him any extra room to work with — keep lateral separation to the bare minimum you require for your turn.

Conversely, if the bandit has significantly better turn performance than your aircraft, deny him the chance to use it by closing in at maximum speed with as little lateral separation as possible.

One-Circle Fights

One-circle fights commence when both you and your opponent happen to loop in the same direction (instead of the opposite direction, as in two-circle fights). One of you sacrifices lateral separation, relying instead on turn radius to out-maneuver the enemy. In general, only use the one-circle fight when you have a significant turn radius advantage over the bandit.

The one-circle fight tends to keep you and your target closer together than the two-circle fight. If you choose to turn away from your opponent, you'll momentarily lose sight of him as he crosses your tail. In fighters with poor rearward visibility, this loss of visual contact can be devastating. Since taking the one-circle approach surrenders the lateral separation to the bandit, you should minimize lateral separation during your next head-on approach.



The Initial Turn

Timing the initial turn in a head-on approach is critical to maintaining the advantage during a fight. Turning too soon pulls you across the bandit's nose, which not only gives him a snapshot opportunity, but also puts you on the defensive. Turning too late, on the other hand, puts you out of position and allows the bandit to gain a better target aspect angle on you.

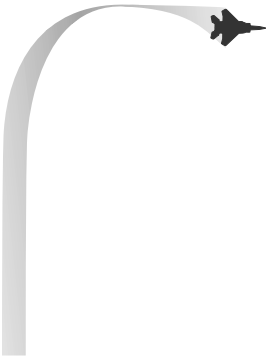
A perfectly timed turn denies the bandit any advantage while maximizing your own performance. However, while the initial turn is important, you may soon find yourself in a twisting, turning fight. When this happens, you need to apply additional air combat skills and maneuvers (discussed in the next section).

Air Combat Maneuvers

In the world of combat, getting into position for a good shot is often called "achieving a firing solution." It can happen in half a second, or it may take several minutes. The manner in which you attain this position differs from conflict to conflict, so it's imperative you develop a good reserve of combat maneuvers.

The following section examines various air-to-air maneuvers and describes how to use them to your advantage during combat.

Break Turn



- Use the break turn to evade enemy fire. Follow with a turn in the opposite direction.
- Initiate a break turn by banking (pull the joystick toward you and to one side).

The break turn is the most basic combat maneuver, for it rapidly increases the Angle-off-Tail (angle between you and your enemy's flight path) when a bandit is preparing to shoot you. It is a high-G maneuver, which takes advantage of a maximum instantaneous turn rate and forces your attacker to take a high-aspect angle shot.

You can make a tight, instantaneous break turn (in which you lose speed, but gain a maximum AoT — Angle off Tail), or you can make a sustained break turn (in which you conserve speed, but forfeit several degrees of AoT). Making a hard break turn bleeds airspeed, which in turn, can cause your enemy to overshoot. Generally, the closer you think the enemy is to firing, the harder you should turn.

Once you move through the break turn, immediately follow it with another maneuver. Sustaining a break turn too long is dangerous — it makes you a wide-open, predictable target. As a rule, your next maneuver should further remove your from the bandit's weapon envelope. Try an immediate scissors turn in the opposite direction. Your opponent will be going too fast to lead your turn, and you may be able to maneuver into a more advantageous position.

Barrel Roll

- Use this as an offensive maneuver to bleed off airspeed when if you're closing too fast during an attack.
- Use this as an defensive maneuver to force your attacker to overshoot.

Offensively, use the barrel roll if you're overtaking an enemy too quickly. Defensively, use the barrel roll to force your attacker to overshoot and pass you. Initiate a barrel roll by rolling slightly and applying pitch. Keep the nose pitched to spiral around the axis of your flight path. The barrel derives its name from the flight path the aircraft performs, circumscribing the shape of a barrel as the aircraft rolls around a central axis. It is an energy management maneuver with both offensive and defensive potential.

Offensive Barrel Rolls

If you find yourself traveling too fast, you may both overshoot your foe and fly directly into his gun envelope. This happens because your closure rate is too high, and you overtake your target. The barrel roll provides an effective solution by wasting speed.

If you can't bleed enough speed with a barrel roll, pull back harder on the stick and execute a roll opposite the direction of your current turn. The increase in pitch reduces airspeed, and the rollout turns you away from the target and keeps you from overshooting. As you complete the roll, you'll be back on your original course, but at a slower airspeed.

Defensive Barrel Rolls

Defensively, the barrel roll can be used to force a quickly approaching attacker to overshoot. It can also maintain enough angle-off-tail to put you out of his lethal cone of fire. Defensive barrel rolls must be carefully timed, however. Initiate the roll too soon, and the bandit follows you through it. Start too late, and the bandit has several shot opportunities before you begin the turn. Perfect timing requires you to both surprise the enemy and deny him sufficient reaction time.

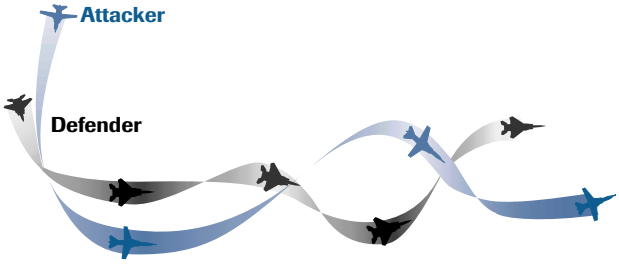
Scissors

- Don't intentionally initiate this maneuver — you lose both speed and altitude.

Scissoring occurs when an attacker overshoots, and the target reacts by making a reverse turn too early (before the attacker crosses his weapon envelope). Never purposefully enter a scissors fight — it bleeds off speed and altitude. To break a stalemate, roll 180° during one of the passes.

Scissoring refers to a series of reversing break turns in which two aircraft turn back and forth toward each other, each trying to force the other out in front.

This usually begins when the attacker starts a late, high-speed yo-yo (see p. 4.67) or barrel roll and realizes he's going to overshoot his target. The defender, predicting the overshoot, reverses his turn. Although this is the right solution, he turns toward the attacker too soon, resulting in a fairly neutral pass and initiating scissors.



Scissor moves reduce the forward velocity vector, or the fighter's speed along the axis of its flight path. The aircraft turns across the flight path at varying speeds, reducing its average forward speed with every turn.

If you're an attacker, the only way you can get into a scissors duel is by starting a maneuver too late and overshooting. If you're on the defensive, you correctly predicted his overshoot, but reacted too quickly and compound the attacker's error.

Once in a scissors, there's nothing to do but keep turning into the bandit. This bleeds off both speed and kinetic energy. The "winner" of a scissors match is usually whoever can conserve enough energy to force his opponent out front and bring the aircraft's nose around for a shot. More often than not, scissoring ends when on aircraft loses so much speed that it stalls out and plummets. If the other aircraft has any energy left, it can roll, dive and take a shot before the falling aircraft can recover.

Vertical Rolling Scissors

Alternatively, two pilots about to engage may begin a series of barrel rolls instead of break turns. The resulting vertical rolling scissors is a speed-reducing maneuver as well, draining kinetic energy during the series of climbs, reverse turns and overshoots. Each time the aircraft cross paths, they risk both collision and gunfire. Allowing too much lateral separation (passing too far apart) affords your opponent a shot opportunity, while passing too close may result in a crash.

In a guns-only environment, you may be able to escape scissors by executing a split-S immediately after crossing your opponent's tail. Then, by rapidly increasing your speed, you can outrun his guns.

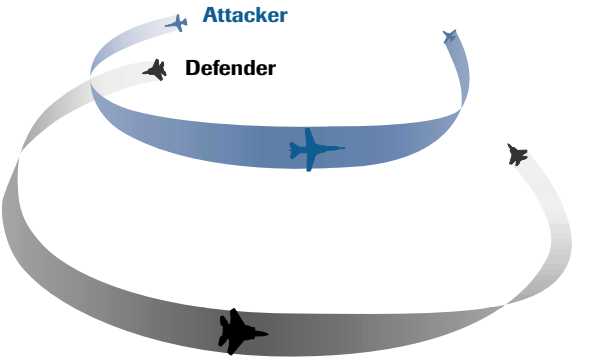
Don't try this if your enemy has IR missiles — the split-S invites a heat seeker up your exhaust pipe. If you can't get outside the bandit's weapon range, then you have to win the scissors fight. If you can't win the fight by out-turning the bandit, you're as good as dead.

Spiral Dive

- Use spiral dives as a last resort, and only if your aircraft has the superior turn radius.
- Fall into a steep dive, then make a hard-G turn. Throttle back midway through the turn and invert. Pull the nose up hard to maneuver onto the enemy's tail.

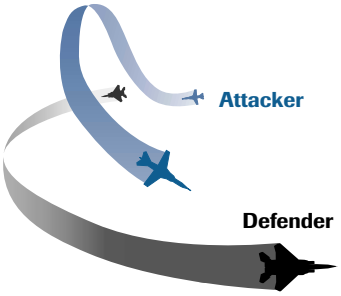
If you use every maneuver imaginable and still can't shake an opponent despite a better turn radius, try a spiral dive. You carry out this maneuver by leading your opponent into a steep dive as soon as he moves to one side of your tail and falls into an overshoot position. He won't have a direct line of fire at you at that instant, but you can't dive for long without him re-achieving a firing solution.

End the dive quickly by taking advantage of your aircraft's superior turn radius and pulling hard pitch (but not so hard that you sacrifice maneuverability). As you come out of the turn, reduce throttle, invert with a 180° roll, and pull up sharply again. Your attacker probably won't notice you've slowed down and he'll be forced out in front of you.



High-Speed Yo-Yo

- Use the high-speed yo-yo to reduce AoT and bring a target into your firing cone.



Perform by relaxing a turn, then pulling up into a sharp climb, Invert, then apply pitch to slide back down onto the threat's tail at a smaller AoT.

The high-speed yo-yo is a basic component of offensive air combat and reduces AoT at the cost of increasing the distance between you and your target. The yo-yo begins during a turning fight when you have assumed an aggressive position behind the bandit, but are stuck in lag pursuit and unable to bring your nose to bear. In this case, you can use gravity to your advantage.

Roll out slightly when your enemy initiates a break turn (maintaining lag pursuit), then pull the nose up. At the apex of the climb, invert and roll back down onto your target's six o'clock position. You'll be further away from him, but in a better firing position.

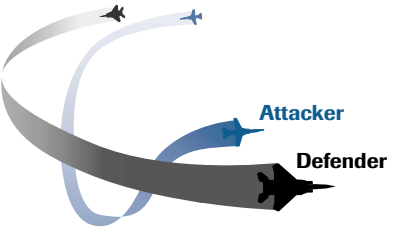
Don't make the yo-yo too extreme. Once you commit to a large one, you'll be unable to respond to any sudden changes the bandit may make. Patiently work small yo-yos by bringing the nose just above the horizon and chipping away at your AoT problem. This moves you into the target's cone of vulnerability without pulling high-G loads.

Rollaway

A variation of the high-speed yo-yo, the rollaway involves rolling away from the target's turn as you invert. By diving and reversing direction with a 180° turn, you can drop in behind the defender's tail as he ends his break turn.

Low-Speed Yo-Yo

- Use the low-speed yo-yo when you have a good firing angle but need to bring the target in range. This maneuver decreases range at the cost of increasing AoT.
- Execute by diving inside of a target's turn and gaining airspeed. Then, pitch up and slide onto his tail once more.



The low yo-yo is the logical opposite of the high yo-yo, and achieves the exact opposite effect. While the purpose of the high yo-yo is to decrease AoT (at the cost of increasing range), the low yo-yo is intended to decrease range (at the cost of increasing AoT).

Use the low-speed yo-yo when you have a good shot opportunity, but you're still outside your weapon's maximum range. This often occurs in chases where the bandit has superior speed and is trying to run home in level flight. You're chasing him, but he remains just outside your weapons' effective envelope.

To get closer to your target, lower your nose below the horizon and dive. This increases speed, but almost always forces you into lag pursuit and increases AoT. A low yo-yo, therefore, almost always requires an immediate high yo-yo to correct the angle problem generated by the increase in speed.

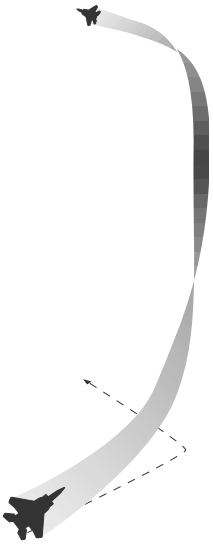
Be careful not to dive too steeply during this maneuver — you may be unable to bring your nose to bear on the target if it ends up too far above you.

Countering a Low-Speed Yo-Yo

If you anticipate your attacker's low-speed yo-yo, try making a half-roll toward the end of your break turn, then roll out of the turn instead of carrying through with the original break turn. By rolling in the opposite direction, you face your attacker' nose as he emerges from his dive. This brings the fight back to a merge pass.

Immelman

- Use this maneuver to increase altitude and reverse direction.

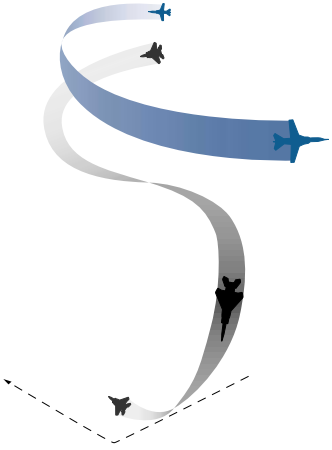


The Immelman is neither an offensive nor defensive procedure. Instead, it is a high-thrust maneuver that changes your bearing and increases your altitude. By pitching the nose up and climbing, you can execute one-half of a loop. To terminate the maneuver, invert and execute a roll. (The amount of roll applied determines your new direction of flight, as indicated in the diagram.) This leaves you flying in a different direction, but at a higher altitude. Once your wings are level, perform a half-roll again to reassume a vertical position.

The Immelman is most useful for aircraft with low thrust capabilities. Modern high-thrust jets can broaden this maneuver by making a vertical climb, then using an aileron roll to complete the half loop.

Split-S

- Use the Split-S to increase airspeed or bleed off altitude.



A Split-S maneuver is a diving half loop useful when you want to disengage a threat. It requires a lot of vertical airspace, so make sure you're at least several thousand feet above the ground before trying it.

During a turn, invert by rolling, then immediately pull back on the stick to go into a dive. Your aircraft rapidly accelerates and gains airspeed. Pull back on the stick until the aircraft levels out — you are no longer inverted, and flying at a higher airspeed and lower altitude.

The split-S has the advantage of providing a quick burst of speed. Additionally, rolling while inverted adds the aircraft's lift vector to gravity, thus increasing the force of acceleration and adding speed. On the down side, however, this increased speed increases the vertical turning radius, making it hard to pull the nose up into level flight. Starting a split-S from low altitude, or maintaining too much speed during the dive, can prevent the aircraft from pulling out of the dive.

The split-S makes a great escape maneuver in a guns-only environment because the rapid speed gain moves you out of gun range. It's usually ineffective against missiles, though, since they have significantly longer ranges.

Engaging Ground Targets

Since ground targets aren't very maneuverable, few actual "combat tactics" exist. The general tactics — surprise and dealing with anti-air defenses — are discussed below.

Surprise

In an attack fighter, try flying in low (500ft above the ground or less), under the enemy's radar. Ground-based radar systems can detect your aircraft at high altitudes, but not close to the ground. If you approach undetected from an unexpected direction, the air-defenses may be unprepared. It takes time for them to turn and engage, giving you an opportunity to deliver ordnance and escape.

Radar waves are like light; they cannot penetrate solid objects like hills and buildings. Try flying at low altitudes between hills or behind clusters of buildings to hide from energy radar. As an added measure, leave your radar in standby mode as you approach an enemy position. Use it only in short bursts to identify target coordinates — this reduces your chances of being detected by their RWR.

Dealing with Anti-Air Defenses

Try to stay outside of enemy defense envelopes. If the target is heavily defended with radar-guided SAMs, approach at low altitude; such SAMs often have trouble engaging low-altitude targets. If the primary defense is automatic anti-aircraft artillery (AAA), fly above 10,000ft.

Similarly, try using long-range weapons like AGM-88s or TV guided missiles. These keep you safely outside the enemy's defenses. Obviously, standoff weapons won't always be available or suitable for a given mission, but always consider using them.

AAA Weaknesses

AAA is deadly against low-altitude targets but does have limitations. While modern AAA uses radar to calculate lead requirements, older AAA systems must eyeball you in their sights and therefore, must lead you. If you approach them from any direction other than head on, you're almost guaranteed they'll miss. Furthermore, the faster you fly and the more you jink, the harder it is for AAA to calculate lead. Keep in mind, however, that the military doctrines of some countries favor indiscriminate barrage attacks, in which no attempt is made to target the aircraft, but as much anti-aircraft fire as can be mustered is pumped in the aircraft's flight path. There is no avoiding a barrage, except to fly above it and take your chances with SAMs.

COMMUNICATION

You always fly in a group called a *flight*, which consists of yourself and up to three wingmen. This arrangement gives both of you mutual support. Constant communication with your wingmen and other flights in your sortie is a must. You don't necessarily control your wingmen, although you can issue certain commands to them and other flights in your sortie.

Typically, you fly with at least on other flight and sometimes up to three flights. If you're flying with all computer friendlies, you are the flight leader. You've also got the ability to configure loadouts for all aircraft in each flight prior to takeoff in the *Tactical Display* screen — see p. 1.15 for details.

During flight, you'll hear radio broadcasts from other aircraft in your sortie, as well as from AWACS, J-STARS and EWR (early warning radar) commanders.

Flight Commands

You can issue the following commands to all wingmen in your flight, or to Flight 2 or Flights 3/4 (if they're in the mission). Commands that start out with "Tell your flight..." send messages to your wingmen.

- To issue commands to Flight 2, press Shift in addition to the key combination listed. (In other words, Shift Alt S tells Flight 2 to sort its targets.)
- To issue commands to Flights 3 and 4, press Ctrl in addition to the key combination listed. (Ctrl Alt S sends the sort command to both flights.)
- The "Lase target" command is specific to Flight 2. To issue it to Flight 3, press Shift Alt L. For Flight 4, press Ctrl Alt L.

Alt S **Sort targets.** Tell your flight to sort targets in a flight containing a target you've locked onto.

Alt W **Engage the other one.** Tell your flight to engage the same type of target you've locked onto (air or ground). If it's an aircraft, your wingmen will lock onto targets in that particular flight.

Alt P **Protect me.** Tell your flight to attack your most threatening air target.

Alt B **Bug out.** Tell your flight to return to base.

Alt H **Anchor.** Tell your flight to hold its current position.

Alt D **Drop tanks.** Tell your flight to jettison all air-to-ground weapons and external fuel tanks.

Alt F **Go to refuel.** Tell your flight to refuel from a nearby tanker.

Alt R **Report status.** Tell your flight to report current status.

Alt L **Lase my target.** Tell Flight 2 to laser-designate a target for you to attack.

Formation Commands

You can instruct your flight to assume certain formations. The diagrams below show the basic design of each formation.

Alt 1 **Go echelon**. Tell your flight to assume Echelon formation.

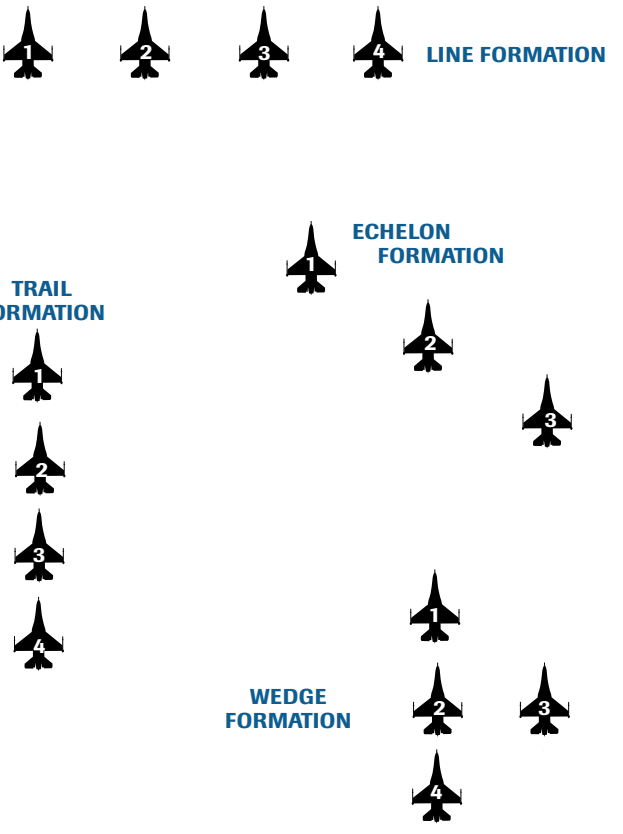
Alt 2 **Go wedge.** Tell your flight to assume Wedge Formation.

Alt 3 **Go trail.** Tell your flight to assume Trail Formation.

Alt 4 **Go line.** Tell your flight to assume Line Formation.

Alt C **Close formation.** Tell your flight to close up the current formation (move closer together).

Alt V **Spread formation.** Tell your flight to switch to spread the current formation (move wider apart).



5

MULTIPLAYER

Previous page: F-15s streak overhead. USAF photo.

Chapter 5

MULTIPLAYER

In *Jane's USAF*, you and your friends can fly in the same flight, as allied squadrons, or against each other via LAN or Internet connection. Jane's USAF supports multiplayer play via TCP/IP (Internet connection) or IPX/SPX (local area network). Modem-to-modem play is not supported. (You can, however, use a modem to connect to your Internet Service Provider for TCP/IP games.) Each player who wishes to join a multiplayer game must have an individual game CD.

Any mission you can fly as a single-player mission can also be flown as a multiplayer mission. Some missions have also been included specifically for use in multiplayer sessions. In addition, you can create missions with the Quick Mission Editor (see p. 1.15).

The rest of this section details how to set up various types of multiplayer games for up to 16 players, as well as how to use the game's in-flight communication. You'll also find information on how multiplayer games differ from normal single-player games. Finally, if you don't want to bother with setting up your connection, you can learn how to use the *Jane's Online* Internet matchmaking service to find other players.

- **Network Connection.** The game can automatically open your connection software if you're not already connected to the network or Internet. Minimize the game or press Alt Tab to switch applications, then connect to your Internet provider. Once connected, return to the game by clicking its name in the *Windows* taskbar.
- **Jane's Online.** You can play multiplayer *Jane's USAF* online by loading the Jane's Combat web site at www.janes.ea.com, and then visiting the online gaming area. You can access this from the *Web* screen within the game.
- To play in the same game, all players must be using the same connection protocol and the same release or patched version of the game.
- All players must have the game CD in their CD-ROM drive.

USING THE MULTIPLAYER SCREEN

When you select MULTIPLAYER from the Main Menu screen, the *Multiplayer Connection* screen automatically appears. From here, you can choose to be a *host* (master player who creates and runs the game) or a *joiner* (a player who joins someone else's game). In general, the player with the fastest computer should host the game. This makes the game run faster for everyone involved.

Connection type. The game automatically detects all of your possible connection methods and displays them in this list on the left side of the screen.

> ***Note:*** *Only protocols and connection methods currently installed on your computer appear here. Internet games, for instance, require TCP/IP to be active in your Network control panel.*

Available sessions. Once you select a connection type (modem, TCP/IP, or IPX / SPX), a list of available games appears in the center of the screen. The right side of the screen displays the callsigns of all players in the selected session. All players who want to play in the same multiplayer session must select the same protocol to be added to this list.

Callsign. Left-clicking this button displays a pop-up window. By default, your callsign is whatever name you typed in when you installed the game. Here, you can type in a different callsign to use for this multiplayer game session.

HOST	Choose to host a new game other players can join.
JOIN	Choose to join a game someone else creates on your LAN.
JOIN BY IP	Choose to join a game someone else creates on a different LAN/subnet. (You must supply the host's remote IP address to connect.)
START	(Host only) Start the game once all players have joined.
QUIT SESSION	Leave the current multiplayer game session. Clicking this button displays a dialog box — select **YES** to quit, **NO** to close the box.

The QUIT SESSION button appears in every pre-flight multiplayer screen.

1. Choose a Callsign (Optional)

When you install the game, you're prompted to enter a callsign. For multiplayer game sessions, however, you have the option of using a different callsign.

1. Left-click **CALLSIGN**. A pop-up window appears.
2. Type in your pilot's callsign (up to 20 characters long).
3. Click **OK** to proceed, or **CANCEL** to close the window.

- You can change your callsign until you join a game (joiner player) or until another player joins a game you've created (host player).

2. Choose a Connection Type

1. Left-click on a connection type listed in the left-hand column. The types you see differ, depending on which protocols you have installed.

   To **host a game**, see p. 5.4.

   To **join an existing network game**, see p. 5.5.

   To **join a remote network game**, see p. 5.5.

- TCP/IP games require the TCP/IP protocol, and IPX/SPX games require the IPX/SPX protocol. You can add these protocols by choosing **Start > Settings > Control Panel** and then double-clicking the **Network** control panel. Click the following buttons in order — **ADD > PROTOCOL > MICROSOFT PROTOCOL DESIRED**, and then select **TCP/IP** or **IPX/SPX**.
- TCP/IP requires a valid Internet Protocol (IP) address. You must also have a connection to the Internet, either through a modem, cable modem, ISDN or ADSL line, or local area network.
- IPX/SPX requires an active connection to your local area network.
- You must use TCP/IP to connect to a different subnet/LAN than the one to which your computer is connected. In addition, you must know the remote system's IP address in advance.

3a. Choose to Host a Game

1. Left-click **HOST**. A pop-up window appears.
2. Type in a name for this multiplayer game (up to 20 characters long).
3. Click **OK** to proceed, or **CANCEL** to close the window.

- Once you click **OK**, your session displays in the *Multiplayer* screen. The name of the session, number of players who have joined and their call-signs, and the session status appear.

OPEN	(Listed in green) Host has created a new game in the lobby, but hasn't clicked **START**. Other players can join this session.
WAITING TO JOIN	(Listed in green) Players can join this session.
CLOSED	(Listed in red) Host has created a session (any game type other than All Out War), and has clicked **START** to begin the session. No additional players can join a closed session.
FULL	(Listed in red) This gaming session is full (16 players are already attached to this game).

4. Wait for all players to join.
5. Once you have the desired number of players (at least two, but up to 16)**,** left-click **START** to proceed.

- At this point, all of your pre-flight selections (i.e., mission parameters you choose) become visible to all joined players.
- A chat window appears onscreen. You can minimize this window by clicking "_" or move it elsewhere on the screen by left-clicking-and-dragging it. Later, you can maximize the window to use it. (See **How to Chat**, p. 5.6, for details on how to chat.)
- You can start the game anytime after only one player has joined, or wait until more players join.

6. Select a mission type from the upper right-hand corner of the screen.

- You can choose any mission type that appears in the game normally, plus a set of special missions (available through the *Special* tab) created specifically for multiplayer combat.
- As the host, you now get to choose the mission parameters. These vary according to which type of game you chose in the previous step. Joiner players can see the options you select, but they cannot change them. See **Setting Mission Options**, p. 5.8, for details.

3b. Choose to Join a Game

1. Left-click on the name of the session you want to join.
2. Click **JOIN**.
3. As soon as the host player clicks **START**, the *Multiplayer Mission* screen appears. There, the host selects the type of mission for this session.
   - A chat window appears onscreen. You can minimize this window by clicking the "—" in the corner of the window. You can move it elsewhere on the screen by left-clicking-and-dragging it. Later, you can maximize the window to use it. (See **How to Chat**, p. 5.6, for details on how to chat.)
   - You do not need to know your machine's IP (network) address to play with someone else on your local area network.
   - If the maximum number of players have already joined the session, "This session is closed" appears onscreen.
   - "This session is closed" appears onscreen if (a) the maximum number of players have joined the game session, or (b) the host has created a game that isn't All Out War, and has clicked **START**.

3c. Choose to Join a Game by IP

1. Left-click on the name of the session you want to join.
2. Click **JOIN BY IP**.
3. Type in the remote IP address for the machine you want to connect to. This number takes the form of XXX.XXX.XXX.XXX and is unique for each machine on a network.
4. Press **OK**.
   - As soon as the host player clicks **START**, the *Multiplayer Mission* screen appears. There, the host selects the type of mission for this session.
   - If the maximum number of players have already joined the session, "This session is closed" appears onscreen.
   - A chat window appears onscreen. You can minimize this window by clicking "—" in the corner of the window. You can move it elsewhere on the screen by left-clicking-and-dragging it. Later, you can maximize the window to use it. (See **How to Chat**, p. 5.6, for details on how to chat.)
   - You can use the **JOIN BY IP** option to connect to a multiplayer session on a remote network. Use this connection method if you don't see any TCP/IP or IPX/SPX games listed in the *Multiplayer* screen, or it you want to connect to a computer on a different subnet (local area network broadcast domain). In both cases, you must supply the IP address of the remote computer.
   - If you still can't seem to connect, make sure neither you nor your fellow pilots are behind firewalls. For LAN security reasons, the game can't operate through a firewall.

COMMUNICATING WITH OTHER PLAYERS

As soon as one or more players join a hosted game, the participants can communicate via the Chat window. Once you host or join a game, the Chat window appears on top of the *Multiplayer Connection* screen. It remains visible until the mission begins. You can minimize this window by clicking "—" in the corner of the window. You can also move it elsewhere on the screen by left-clicking-and-dragging it. Maximize the window to use it again.

Before flight: Prior to takeoff, the Chat window shows which actions players are performing. (For instance, if you select an aircraft type in the *All-Out War* screen, everyone else is informed through the Chat window — "I chose an aircraft" appears next to your callsign.)

During flight: Once you're airborne, you can chat with other players, including the game's host. You can send messages to all players, friendly or enemy players, or to a specific player. All chat messages display at the top of the HUD.

Some messages are sent automatically, both before and after flight. Different conditions generate these messages — for example, whenever a player joins or leaves a session, clicks **FLY**, rejoins a battle after dying, loads a mission, or selects an aircraft. Other messages are constructed by individual players and sent to various recipients.

How to Chat

You use the same keystrokes for chatting both before and during flight.

[~`]	Initiate chat message to all players
[Alt] [~`]	Initiate chat message to friendly players
[Shift] [~`]	Initiate chat message to enemy players
[~`]	Initiate chat message to locked target (available only if you have a target locked)
[~`] and [↑]/[↓]	Alternatively, you can cycle through message recipients by initiating chat normally (press [~`]) and then using the arrow keys to switch channels. The order is: ALL PLAYERS / ALL FRIENDLIES / ALL ENEMIES / TARGET.
[Enter]	Send chat message
[Esc]	Abort message and terminate chat mode

- Each chat message can be up to 48 characters long.
- As soon as the sender selects a recipient, the name of the channel displays onscreen (i.e., ">SEND TO FRIENDS:").

Preset Chat Messages

You can send preset messages to the currently selected recipient(s). First, select a chat recipient (described in the previous section). Then, press the appropriate function key. Whenever you send a preset chat message, an associated radio broadcast plays in all receiving aircraft.

Key	Function	Radio Broadcast
F1	Send positive confirmation	"Roger."
F2	Send negative confirmation	"Negative."
F3	Ask for help	"I'm in trouble ... help me out!"
F4	Attack this target	"Take the <MiG 21> number <1>." (automatically inserts bracketed target information)
F5	Tell recipient to join formation	"Follow me."
F6	Issue missile warning	"Break! Missile!"
F7	Tell recipient to quit the fight	"We're bugging out!"
F8	Ask for cover support	"Watch my back!"
F9	Offer cover support	"Attack, I'll cover!"
F10	Warn about friendly fire	"Stop shooting! I'm on your side!"
F11	Send depressing message	"I'd better be grounded."
F12	Send teaser message	"How does it feel to eat lead?"

Note: *The game's voice recognition feature does not work with multiplayer chat. It is only used to give commands to your aircraft. See* ***Preferences Window****, p. 8.1.*

MULTIPLAYER MISSIONS

Setting Mission Options (Host Only)

The options you can change vary according to the mission type. This section lists bulleted items you can alter in each game type. For a complete description of how to use each screen and learn what the options mean, refer to **Interface** (p. 1.1).

- Joiner players can't ever select their own loadouts. The host player determines the loadouts for all aircraft.
- Joiner players can't control what mission will be flown in a multiplayer session. The host selects the mission or mission type.
- Anyone can quit a multiplayer session at any time by pressing QUIT.

Special

These six missions are specific to multiplayer combat. Players divide into force teams and fly missions specially designed for multiplayer play.

- Aircraft types are fixed, but the host can select specific weapons for each aircraft in each flight.
- You can't score points during Special missions.

Single

See **Interface: Single Missions Screen**, p. 1.9, for details on Single Missions.

- Aircraft types are fixed, but the host can select specific weapons for each aircraft in each flight.
- You score normally during multiplayer Single missions. (Points you accumulate are added to the currently selected pilot's score.)

History/Future

See **Interface: Campaign Screen**, p. 1.10, for details on Historical and Future campaign missions.

- Aircraft types are fixed, but the host can select specific weapons for each aircraft in each flight.
- You score points normally during these missions. (Points you accumulate are added to the currently selected pilot's score.)

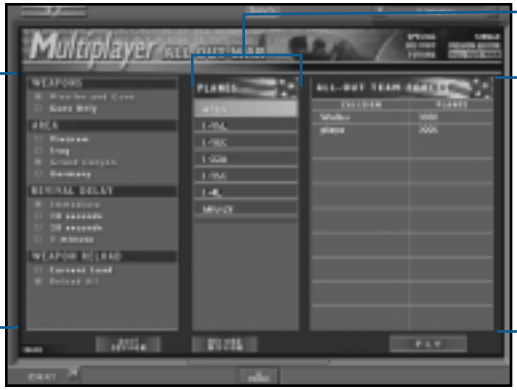
Quick Mission Editor

See **Interface: Quick Mission Editor Screen**, p. 1.5, for details on options you can select in the *Quick Mission Editor* screen.

- You can't score points while flying missions created in the User Mission Editor or Quick Mission Editor.

All-Out War

All-Out War is a multiplayer-specific game that pits all players against one another. The goal is to shoot down all other aircraft as many times as possible, and the person with the most kills at the end of the mission wins.



During flight, each player's callsign and current score appears in the upper right corner of the screen. The first number represents the number of opposing aircraft that player has downed, while the second one represents the number of times that player has been killed.

- All players get to select their own aircraft — the F-105D, F-4E, A-10A, F-15C, F-15E, F-16C, F-117A, F-22A, or MiG-29.
- All weapons are automatically configured for air-to-air combat.
- As long as 16 players aren't already flying, you can join an All-Out War game even after it's started.
- The starting altitude for each aircraft is 15,000ft. All aircraft initially face a common, central waypoint.
- You can't score points during All-Out War missions.
- The host can select general loadouts (AA, AG or both) for all players.
- The host can set the following game parameters.

Weapons. (Host only) Type of weapons to be loaded onto each aircraft (MISSILES AND GUNS / GUNS ONLY).

Area. (Host only) Terrain over which the mission occurs (GRAND CANYON / GERMANY / VIETNAM / IRAQ).

Revival Delay. (Host only) How long players must wait before rejoining combat (IMMEDIATE / 10 SECONDS / 20 SECONDS / 1 MINUTE).

Weapon Reload. (Host only) What weapons regenerate when a player rejoins combat (CURRENT LOAD / RELOAD ALL). Choosing current load causes the aircraft to regenerate with whatever weapons it had when it was destroyed. Choosing reload all completely restocks the aircraft's stores.

Aircraft. Type of aircraft (chosen by each player).

Dying/Rejoining Combat

If the mission supports revival and the host player has selected a number higher than "1," you can rejoin a fight if you die. After you crash or are shot down, a pop-up window displays with the following options:

YES Rejoin the flight in the same aircraft with the same loadout.

NO Close the window and return to the *Multiplayer Connection* screen. (If you are the host player, this ends the session for all players.)

- When you rejoin a fight, your aircraft is always placed 10nm further away than where you were killed.

Ending the Game

To leave a multiplayer game session prematurely, press Ctrl Q. This displays a pop-window with the following options:

DEBRIEF Display the **Debrief Screen** (p. 1.25).
(Joiner) Player leaves the game and views the *Debrief* screen, but no one else is affected.
(Host) The game ends for everyone, and all players see the *Debrief* screen.

CONTINUE Close the window and resume the mission.

QUIT SESSION End the mission and terminate the multiplayer session.
(Joiner) No debrief information displays, and the player returns to the *Multiplayer Connection* screen. No one else is affected.
(Host) The game ends for for everyone, and all players return to the *Multiplayer Connection* screen).

This window pops up automatically once the mission objectives have been met. Only the Host player has the ability to end the mission for all players before success criteria have been met. If a player or side meets the victory conditions for the session, this popup window appears for all players. As long as the host player chooses **CONTINUE** to keep playing, other players can choose **CONTINUE** and keep playing after the mission is won.

Multiplayer Scoring

Scoring in multiplayer game sessions is similar to scoring in normal single-player games. However, you can't accumulate points in all types of games. (For information on scoring and promotions, see **Interface: Rank**, p. 1.31, or the printed *Install Guide*.)

- You score points normally in Future, Single, and Historical multiplayer game sessions. (These points are added to the currently selected pilot's score at the end of the mission.)
- You can't score points in certain types of missions — Fly Now, Special, Quick Mission Editor, or All-Out War.

6

BACKGROUND INFORMATION

Previous page: An A-10A takes off. USAF photo by Senior Airman Stan Parker.

Chapter 6

HISTORY OF THE US AIR FORCE

Note: *This article was originally published by the United States Air Force and titled "Evolution of the Department of the Air Force." It can be found in the subject list at www.airforcehistory.hq.af.mil. Section titles have been inserted for clarity.*

The Department of the Air Force, an agency of the Department of Defense, was established on September 18, 1947, pursuant to provisions of the National Security Act of the previous July 26. On September 26, 1947, by order of the Secretary of Defense, personnel of the Army Air Forces (AAF) were transferred from the Department of the Army (formerly the War Department) to the Department of the Air Force and established as the United States Air Force (USAF). As this history shows, the Air Force can claim lineal antecedents long predating the 1947 act.

Chronology of the USAF

Aeronautical Division, US Signal Corps	Aug. 1907–July 1914
Aviation Section, US Signal Corps	July 1914–May 1918
Division of Military Aeronautics	May 1918
Air Service	May 1918–July 1926
*Air Corps**	July 1926–Sept. 1947
Army Air Forces	June 1941–Sept. 1947
United States Air Force	Sept. 1947

* The Air Corps became a subordinate element of the Army Air Forces on 20 June 1941, and it continued to exist as a combat arm of the Army until 1947.

Early Combat Aircraft

The USAF had its roots in a turn-of-the century effort at technology assessment. In January 1905, the War Department took up consideration of an offer it had received from two inventors in Dayton, Ohio, to provide the government with a heavier-than-air flying machine. The fact that many still doubted the claim of Wilbur and Orville Wright to have invented a workable airplane is part of the history of aviation. But the Board of Ordnance and Fortifications, which examined the Wrights' proposal, had other facts to consider as well. Outside the realm of science fiction, the role in warfare of airships, gliders, and airplanes was by no means clear. Only balloons had proven value of any sort. The French revolutionaries had used a balloon at the battle of Fleurus in 1794. In the American Civil War, balloons had seen service, and the job of procuring and operating them had duly passed to the Signal Corps. Only in 1892, however, did the Signal Corps organize a permanent balloon section, and this unit's service in the war with Spain in 1898 was undistinguished. In 1898, the Signal Corps contracted with Samuel P. Langley for an airplane, but tests ended with a spectacular dive into the Potomac River on December 8, 1903, nine days before the Wright brothers

flew. The War Department, still smarting from that episode in 1905, turned down the new offer.

But the progress of aviation, the issuance of a patent to the Wrights in 1906, and the interest of President Theodore Roosevelt brought the matter up again. In 1907, the Aeronautical Division of the Signal Corps was established to develop all forms of flying. In 1908, the corps ordered a dirigible balloon of the Zeppelin type then in use in Germany and contracted with the Wrights for an airplane. Despite a crash that destroyed the first model, the Wright plane was delivered in 1909. The inventors then began to teach a few enthusiastic young officers to fly.

World War I and Military Aviation

The progress of American aviation was slow in the early years. Congress voted the first appropriation for military aviation in 1911. The Navy was starting its own program at about the same time. Soon after, the aviators rejected a proposal to separate their service from the Signal Corps. A makeshift squadron had an unlucky time with General John J. Pershing on the Mexican border in 1916. What really proved the importance of military aviation was its role in Europe during World War I. There balloons used for artillery spotting and airplanes for reconnaissance over enemy lines made a decisive contribution. Dirigible airships and airplanes proved effective at bombing. Every army sought control of the air, and great battles between the "knights of the air" became the stuff of romance. Yet at the same time a serious doctrine of air warfare was beginning to emerge. The commanders began to distinguish, for example, between "strategic" air operations, deep in an enemy's territory, directed at his vital war-making industries and civilian morale, and "tactical" operations against his ground forces.

US Military Aircraft in World War I

At the time of America's declaration of war against Germany on April 6, 1917, the Aviation Section was marginal at best. Its 1,200 officers and men had no knowledge of the air war in Europe. Its 250 airplanes and 5 balloons could not have survived long in combat. The nation's aircraft manufacturers had up to that time produced 1,000 planes. Yet, when France asked the United States to provide an air force of 4,500 airplanes and 50,000 men, there was no hesitation. With more enthusiasm than wisdom, Secretary of War Newton D. Baker asked for and received $ 640 million from Congress for aviation. The result was a fiasco. By the spring of 1918, it was clear that the Signal Corps had failed. The War Department then set up an Air Service consisting of two agencies: one under a civilian to deal with the manufacturers and one under a military officer to train and organize units. This setup, begun in April and May, was consolidated in August, when President Woodrow Wilson appointed John D. Ryan, Second Assistant Secretary of War, as aviation "czar" to straighten out the mess.

In the end the only American achievement in the field of aircraft production

was the Liberty engine. Of the 740 U. S. aircraft at the front in France at the time of the Armistice on November 11, 1918, almost all were European-made. Still, the Air Service of General Pershing American Expeditionary Forces, organized by Major General Mason M. Patrick and Brigadier General William (Billy) Mitchell, had distinguished itself in action against the Germans.

Creation of an Independent Air Force

As a result of the important role air power had played in the war, a movement developed during the 1920s and 1930s to create an independent air force. The model for this was Great Britain, which, early in 1918, had combined its Army and Navy air arms into the Royal Air Force (RAF) under an Air Ministry. But the U. S. Army's leaders saw the airplane primarily as a weapon for supporting the infantry and gave the Air Service a status comparable to that of the field artillery or the engineers, responsible for procuring aircraft and training flying units. Local commanders, none of them aviators, ran the air forces assigned to them. A series of boards and commissions studied and restudied the question of air organization, with no result other than the name change to Air Corps in 1926.

Nevertheless, just as in the RAF, the formulation of theories of strategic bombing gave new impetus to the argument for an independent air force. Strategic or long-range bombardment was intended to destroy an enemy nation's industry and war-making potential, and only an independent service would have a free hand to do so. Amid intense controversy, Billy Mitchell came to espouse these views and, in 1925, went to the point of "martyrdom" before a court-martial to publicize his position. But despite what it perceived as "obstruction" from the War Department, much of which was attributable to a shortage of funds, the Air Corps made great strides during the 1930s. A doctrine emerged that stressed precision bombing of industrial targets by heavily armed long-range aircraft. A big step was taken in 1935 with the creation of a combat air force, commanded by an aviator and answering to the Chief of Staff of the Army. Called the "GHQ Air Force" because it would be under the General Headquarters in time of war, this command took combat air units out of the hands of the local commanders in the continental United States. Nonetheless, the GHQ Air Force remained small when compared to air forces in Europe. The Air Corps could only buy a few of the new four-engined B-17 Flying Fortresses, designed for strategic bombing, and in 1938, there were only thirteen on hand.

Painting Army Air insignia on the fuselage of a B-25 bomber at North American Aviation plant in Inglewood, CA (ca. 1942).

NARA photo NLR-PHOCO6657(25)

World War II Developments

World War II was the true age of liberation for American air power. Reports from Europe in 1939 and 1940 proved the dominant role of the airplane in modern war. On June 20, 1941, Major General Henry H. Arnold, then chief of the Air Corps, assumed the title of chief of Army Air Forces and was given command of the Air Force Combat Command, as the GHQ Air Force had been renamed. (Arnold's title was changed to "Commanding General, Army Air Forces" in March 1942, when he became co-equal with the commanders of Army Ground Forces and Services of Supply.) The AAF was directly under the orders of the Chief of Staff of the Army, General George C. Marshall. Arnold and Marshall agreed that the AAF would enjoy autonomy within the War Department until the end of the war, when the air arm would become a fully independent service. Soon after the Japanese attack on Pearl Harbor on December 7, 1941, Arnold gained another victory. In staff talks with the Americans, the British always included representatives of the RAF as well as the Army and Navy, so the United States had to include an air representative of its own. Arnold, although technically Marshall's subordinate, became an equal with him on the Joint Chiefs of Staff, the body that served as the focal point of American strategic planning during the war.

US Army Air Force gunner fires a machine gun in a World War II aerial battle with German planes over Europe (circa 1942).

NARA photo NLR-PHOCO-65639)31)

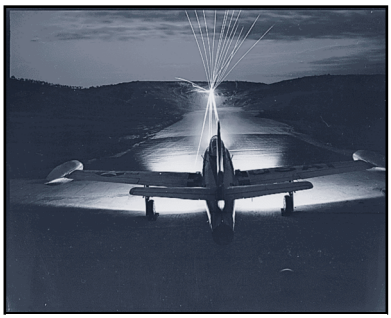
In its expansion during World War II, the AAF became the world's most powerful air force. From the Air Corps of 1939, with 20,000 men and 2,400 planes, to the nearly autonomous AAF of 1944, with almost 2.4 million personnel and 80,000 aircraft, was a remarkable expansion. Robert A. Lovett, the Assistant Secretary of War for Air, together with Arnold, presided over an increase greater than for either the ground Army or the Navy, while at the same time dispatching combat air forces to the battlefronts. Air Combat Command was discontinued, and four air forces were created in the continental United States. In the end, twelve more air forces went overseas and served against the Germans and Japanese.

As Arnold's staff saw it, the first priority in the war was to launch a strategic bombing offensive in support of the RAF against Germany. The Eighth Air Force, sent to England in 1942, took on that job. After a slow and often costly effort to bring the necessary strength to bear, joined in 1944 by the Fifteenth Air Force stationed in Italy, the Eighth finally began to get results. By the end of the war, the German economy had been pounded to rubble. Meanwhile, tactical air forces supported the ground forces in the Mediterranean and European theaters, where the enemy found allied air

supremacy a constant frustration. In the war against Japan, General Douglas MacArthur made his advance along New Guinea by leap-frogging his air forces forward, using amphibious forces to open up new bases. The AAF also assisted Admiral Chester Nimitz's carriers in their island-hopping across the Central Pacific and supported Allied forces in Burma and China. Arnold directly controlled the Twentieth Air Force, equipped with the new long-range B-29 Superfortresses used for bombing Japan's home islands, first from China and then from the Marianas. Devastated by fire-raids, Japan was so weakened by August of 1945 that Arnold believed neither the atomic bomb nor the planned invasion would be necessary to win the war. The fact that AAF B-29s dropped the atomic bombs on Hiroshima and Nagasaki, nevertheless, demonstrated what air power could do in the future. The U. S. Strategic Bombing Survey provided ammunition for the leaders of the AAF in the postwar debates over armed forces unification and national strategy.

Post-World War II

After World War II, independence for the Air Force was virtually inevitable. The War Department favored unification of the Army and Navy, with co-equal land, sea, and air services under a single head. The Navy opposed this plan and forced adoption of a compromise in the National Security Act of 1947. This law created the Department of the Air Force and gave a Secretary of Defense limited authority over the services. By the time the law went into effect in September, the Air Force was beginning to rebuild after the postwar demobilization. Its leaders had defined a goal of establishing 70 combat groups with 400,000 men and 8,000 planes. Stringent postwar budgets delayed the program in spite of concerns of the growing threat from the Soviet Union. As the United States came to rely upon a strategy of deterrence, the Air Force gave highest priority to its long-range atomic bombing force, using air refueling to lengthen its reach. Acrimonious disputes with the Navy resulted, focusing on the roles of the services in modern warfare, until the large budget increases after 1950.



Leaving a fiery trail, .50 caliber bullets streak through the night as maintenance men of the 49th Fighter Bomber Wing in Korea, test fire a Republic F-84 "Thunderjet" (August 1952).

NARA photo NWDNS-342-AF-81859AC

Multiple Combat Commands

In 1946, the AAF had created three major combat commands in the United States: the Strategic Air Command (SAC), the Tactical Air Command (TAC), and the Air Defense Command (ADC). The Strategic Air Command now became the centerpiece of Air Force planning. Yet, surprisingly, the first important intervention of the Air Force in the Cold War was by the Military

Aircrew of a 5th AF B-26 Invader preparing for a night mission over enemy territory in Korea (June 1951).

NARA photo NWDNS-342-AF-80250AC

Air Transport Service (MATS) during the Berlin Airlift of 1948-1949. Still, SAC's role remained predominant, especially during the service of Curtis E. LeMay as its commander (1948-1957). Rising to a level of peacetime readiness unprecedented in American history, SAC was not dethroned even during the fighting in Korea (1950-1953). Tactical forces were built up to take part in the fighting in support of the United Nations forces, and SAC even sent B-29 bombers. The American air forces achieved control of the air and poured bombs onto the Communist supply lines. But the increased budget for the Air Force also went to build up tactical forces in Europe and for a worldwide strategic striking force. After the Soviets detonated an atomic bomb in 1949, a new emphasis on air defense brought the ADC into the picture, but the TAC remained slighted throughout the 1950s, even with the development of tactical nuclear weapons.

The 1950s also witnessed the centralization of the Department of Defense. In 1949 the Secretary of Defense gained greater authority over the services, and the service secretaries ceased to be members of the National Security Council. By 1958, this process had reached the point that, not only the commands overseas, but even SAC and ADC were under the overall control of the Joint Chiefs of Staff. Nevertheless, the Chief of Staff of the Air Force had great influence as a member of the Joint Chiefs, and the Air Force kept direct responsibility to "organize, train and equip" combat air forces.

Air Force Research

Under the influence of such farsighted officials as Trevor Gardner (at one time Assistant Secretary of the Air Force for Research and Development) and Major General Bernard A. Schriever, who founded what was to evolve into the Space and Missile Systems Center, the Air Force developed ballistic missiles during the 1950s. SAC began to supplement its great armada of bombers with missiles in 1959. By the end of the 1960s, over a thousand intercontinental ballistic missiles were in place, while the long-range bomber force had been cut back. The Air Force thus had two elements of the "Triad" of strategic weapons (bombers and land-based missiles), while the Navy had the third (submarine-launched missiles). Also in the 1960s, as a result of Secretary of Defense Robert S. McNamara's emphasis on "flexible response" in the strategy of deterrence, the TAC enjoyed something of a revival. Thus, even before large-scale intervention in Southeast Asia, the Air Force's conventional capabilities were increasing.

Besides ballistic missiles, the Air Force became involved with earth satellites during the 1950s. In 1961 the service began supporting an independent, highly secret agency, the National Reconnaissance Office (NRO), that handled intelligence satellites. The head of this office was placed in the office of the Secretary of the Air Force, and the NRO was staffed largely with Air Force people. The existence of this office was only disclosed in the 1990's.

The Air Force in Asia

As part of the American effort to assist the government of South Vietnam in counterinsurgency operations during the early 1960s, the Air Force sent advisers to the Vietnamese Air Force. During 1964 and 1965 the commitment was increased, and combat units went into action. In South Vietnam, tactical forces, with the assistance of B-52 bombers from SAC, supported U. S. and Vietnamese ground forces. Tactical forces in Vietnam and Thailand took part in strikes at crucial targets in North Vietnam and along supply trails in southern Laos. There were also strikes in support of the counterinsurgency operations of the Laotian government. Operations over Cambodia were in support of the war in South Vietnam. SAC provided tanker aircraft for refueling. Yet this, the first war fought under the 1958 reorganization act, was conducted without a single Air Force agency controlling all air operations in Southeast Asia. Most operations were controlled by the theater commanders.

As the war went on into the climactic bombings of 1972, the Air Force struggled to remain ready in other areas. SAC had to divert much of its bomber and tanker forces to Southeast Asia, and tactical forces in Europe were affected as well. With the end of the fighting, contending with stringent budgets, the Air Force turned to the job of upgrading the strategic deterrent force and maintaining readiness in Europe. In the meantime, the strategy of deterrence had evolved to the doctrine of mutually assured destruction, enshrined in the strategic arms limitation agreement with the Soviet Union in 1972. The declining emphasis on defensive forces affected the Air Defense Command, now renamed the Aerospace Defense Command, which was abolished in 1980.

Post-Vietnam

Despite the cutbacks after the war in Southeast Asia, the Air Force focused on heightened combat readiness. The Military Airlift Command (formerly MATS) gave military and humanitarian support for the nation's global commitments, as in the support to Israel in the Middle East war of 1973. Increases in appropriations, begun under the administration of President Jimmy Carter, produced a major buildup under his successor, Ronald W. Reagan. The peak was reached in the period of 1985-1986, when the Air Force attained annual spending levels of $ 97 billion and a strength of over 600,000. Force deployments in support of operations in Grenada (1983), against Libya (1986), and in Panama (1989) reflected a growing capacity for quick response to local crises. At the same time, arms control negotiations with the Soviet Union began, slowly, to bear fruit.

Commitment to Research

Since the days of the Army Air Service, the air arm has relied primarily on private industry for the manufacture of airplanes. The continuing search for balance between the required quantities and the most modern equipment has also usually involved a commitment to preserving a strong industrial base. One of Arnold's personal legacies was a commitment to research and development. The results appeared in the 1990s in such applications of low-observables ("Stealth") technology as the B-2 bomber and the F-117 fighter-bomber. The C-17 transport represented state-of-the art design as well. The development of the F-22 fighter continued a commitment to air superiority, while unmanned air vehicles (UAVs) suggested new directions.

Personnel Developments

Because of the highly complex modern weapon systems the Air Force has sought to use, the demand for skilled personnel has always been high. The need applied both to flying crew, especially pilots, and ground maintenance technicians. During the periods of the draft, in both world wars and from 1948 to 1973, the air arm was able to attract volunteers, emphasizing programs for recruiting and keeping people for training in innumerable skills. The Air Force Academy (founded in 1955 and soon located outside Colorado Springs) and higher service schools at the Air University, Maxwell Air Force Base, Alabama, developed the leadership cadres of the service. Recruiting and retaining able pilots was a perennial cycle of ups and downs, with budget pressures affecting student intake, as well as pay and benefits, the burden of global deployments, and competition with the airlines.

When President Harry S Truman in 1948 directed an end to racial discrimination in the armed forces, the Air Force was positioned to be a pioneer in integration. African-American combat air units served with distinction in the Second World War, but segregation had proved unworkable. Although the upheavals of the 1960s did lead to trouble in the Air Force — most notably in race riots at Travis Air Force Base, California, in 1971 — on the whole, integration proved a success. In 1997 some fifteen percent of the active duty force was black, while other ethnic minorities were also strongly represented. A number of African-Americans had also risen to high rank, although the percentage of blacks in the officer corps was still below ten in 1997.

Crew chief of the African-American 15th AF closes the canopy of a P-51 Mustang as the pilot prepares to take off from their World War II operations base in Italy.

NARA photo NWDMS-208-AA-46BB-6

The end of Selective Service in 1973 ushered in a new era in personnel policy for the armed forces. The All-Volunteer Force was going to have to recruit women more energetically and would probably need to place more reliance on reserve forces. The Women's Army Corps (WAC) had assigned units to the AAF in the 1940s, and in 1948 the Women in the Air Force (WAF) was formed. The new approach did away with the WAF organization in order to integrate women more fully into the service. By the 1990s, female personnel were serving in virtually every specialty, including bomber pilots and missile crews. Over one sixth of the active force were women in 1997. At the same time, the Total Force concept matured as the means to integrate the Air National Guard and the Air Force Reserve more closely with the active force.

A Women's Air Force service pilot looks around before taking off from an air base in Harlingen, TX (ca.1930-1975).

NARA photo NWDNS-342-AF-77472AC

The Modern Air Force

Up until 1989, the Air Force's existence as an independent service had coincided with the Cold War. Now, facing a new strategic challenge, the U. S. could cut back the nuclear forces on strategic alert as a result of arms control. But the final collapse of the Soviet Union in 1991 simply eliminated the artificial order that had been imposed on a disorderly world, and local enmities became increasingly violent. The most spectacularly successful intervention by the U. S. Air Force in these outbursts was in the Persian Gulf in 1991. Supporting a coalition designed to expel Iraqi forces from Kuwait in January, the Air Force led the way in a six-week campaign that was a triumph in the application of air power.

The post-Cold War drawdown of forces reduced the Air Force budget to $73 billion in 1997, with a strength of 380,000. In 1992 the service acknowledged the new global reality with a reorganization in which the main flying forces in the continental U. S. were put into two major commands: Air Combat Command and Air Mobility Command. Later interventions in such places as Bosnia still demonstrated the effective combination of high technology with skill and determination to apply force in difficult situations. In particular, the application of space technology in these conflicts gave the Space Command (first created in 1982) a pioneering role as the Air Force looked to the twenty-first century. And at the same time, Air Mobility Command's airlift force continued to be an essential instrument of national policy all over the world. Still, by the late 1990s, the Air Force, like all the armed services, was facing extreme pressure to meet global commitments with declining resources.

CAMPAIGN BACKGROUNDS

The following information provides additional background information for each of the campaigns in *Jane's USAF*. The sections on the Vietnam and Desert Storm historical campaigns chronicle the US Air Force's involvement in those operations. The section on the Operation Red Arrow campaign explains the history and purpose of the USAF Red Flag training program based at Nellis AFB. This campaign simulates the type of exercises conducted in Red Flag, having pilots-in-training defend against a fictional attack on the continental United States. Finally, the final section sets up a fictional background "history" for the Operation Sleeping Giant campaign, based in Germany. Events in this history that take place before 1999 are real, and the articles from Jane's Information Group describing them are also real. Naturally, articles dated later than 1999 are fictional.

Vietnam

USAF involvement in the Vietnam conflict began as early as 1961, when the US began sending Army and Air Force personnel to South Vietnam as trainers and advisors. By 1968, over 54,434 USAF personnel and 737 planes were conducting operations from bases in South Vietnam and Thailand. Throughout the war, air support operations took place within South Vietnam, while the USAF alternated between bombing campaigns and reconnaissance missions over North Vietnam, Laos and Cambodia.

South Vietnam

American forces initially arrived in South Vietnam to shore up domestic militia and defense forces, in the hopes of thwarting an aggressive takeover by a Vietnamese nationalist communist party, the Viet Cong, which controlled the government in North Vietnam under the leadership of Ho Chi Minh. By the mid-1960s, the US was conducting air and ground attacks against Viet Cong forces that continued to infiltrate South Vietnam.

Before the Gulf of Tonkin Incident

From 1961-1964, US airmen in South Vietnam were not authorized to engage in combat with the Viet Cong. Their mission was to train and equip South Vietnamese forces to engage the North Vietnamese without US assistance. Once training was complete, US officials planned to withdraw all forces from the area. USAF personnel also flew reconnaissance missions over South Vietnam and Laos during this period to monitor arms, personnel and equipment movement along the Ho Chi Minh Trail through the Laotian mountains. Although North Vietnamese forces had not yet *overtly* targeted American troops, since both South Vietnamese and American personnel conducted operations in American aircraft, danger to US airmen was significant. As a result of American casualties, US rules of engagement were eventually relaxed to permit personnel to engage in defensive combat under very limited conditions. However, the role of US forces in Vietnam was still limited to training and reconnaissance.

On 2 August 1964, the Viet Cong conducted its first overtly hostile action against the United States, when three North Vietnamese torpedo boats began attacks on the USS *Maddox*, and later the USS *C. Turner Jay*, which were both stationed in the Gulf of Tonkin. In response to this aggression, the United States Congress passed the Gulf of Tonkin Resolution (H.J. Congress RES 1145), giving the President authority to use any measures — up to and including armed force — to assist the South Vietnamese.

Air Support

By 1965, Washington officials were no longer anticipating the withdrawal of American forces from Vietnam. The South Vietnamese forces were losing ground against the Viet Cong and attacks against US forces were increasing. Additional US troops and equipment were sent to South Vietnam, and in March 1965, the USAF began "Rolling Thunder" operations against North Vietnam. Concerted air to ground defense against Viet Cong troops within South Vietnam also began toward the end of 1965, as the Viet Cong began mounting large-scale attacks on US and South Vietnamese positions.

Napalm bombs explode on Viet Cong structures south of Saigon, ca. 1965.

NARA photo NWDNS-342-C-K20652

US strength in South Vietnam had reached 486,000 troops in 1967, backed by additional forces from South Korea, Australia and New Zealand. The US and its foreign allies focused on combating the North Vietnamese forces within South Vietnam, freeing the South Vietnamese troops to work on ending native support for the Viet Cong in the countryside. North Vietnamese successes diminished for a time, but the Viet Cong began building forces in Cambodia and Laos for a renewed offensive. The Tet Offensive began in late January with an attack on a US Marine base at Khe Sanh. A few days later, the Viet Cong followed with a series of simultaneous attacks on numerous airfields and installations throughout the country. During this offensive, the Viet Cong attacked South Vietnamese cities for the first time, where the violence and bloodshed were readily visible to American reporters and TV news crews. As the images from the Tet Offensive were relayed back home, American support for the war began eroding quickly. Once more, US officials began planning to turn responsibility for the war over to the South Vietnamese and withdraw. In the meantime, they sent more personnel to Vietnam to speed up this process of "Vietnamization."

Vietnamization

President Nixon further accelerated Vietnamization as he took office in January 1969. The first US troops left in July, and by the end of the year 69,000 had been withdrawn. By 1970, the first USAF units were withdrawn as the VNAF (Vietnamese National Air Force) capabilities were expanded. Still, the USAF flew over 48,000 sorties, striking against North Vietnamese forces that had infiltrated South Vietnam. USAF forces had been reduced to about half of their highest personnel strength by the end of 1971, and the VNAF had taken over 70% of all air combat operations within the country.

In March 1972 North Vietnam began a large-scale invasion of South Vietnam and by June occupied much of the country. Nixon retaliated with Operations Linebacker and Linebacker II, intense bombing campaigns against North Vietnam and the aerial mining of its harbors. On 29 December 1972, North Vietnamese officials agreed to begin negotiating a cease-fire, which was completed on 23 January 1973. By March, the last US military personnel had been withdrawn from South Vietnam.

North Vietnam

Rolling Thunder

Rolling Thunder was a systematic bombing attack on North Vietnam, conducted from USAF bases in Thailand and South Vietnam from 1965 to 1968. The operation called for initial attacks to be conducted in the area just north of the DMZ (demilitarized zone) that had been established when French forces withdrew from the country under the Geneva Agreements of 1954. The USAF would then gradually begin shifting its target areas northward, hoping to pressure North Vietnamese leaders into agreeing to attempt diplomatic peace negotiations.

Flying under radar control with a B-66 Destroyer, F-105 Thunderchief pilots bomb a target through low clouds over the southern panhandle of North Vietnam (14 July 1966).

NARA photo NWDNS-306-MVP-15(14)

Early Phases

From the beginning, strict rules of engagement governed the bombing attacks. Keeping civilian casualties to a minimum was of primary concern, and officials in Washington limited what could be targeted, where it could be targeted and even how the bombing runs could be conducted in some instances. The air-to-surface weapons available for Rolling Thunder were not accurate enough for precision strikes in urban areas, and bombing tactics were often altered to minimize civilian casualties. Such alterations often reduced the USAF's ability to hit its targets — for example, pilots were required to fly bombing runs perpendicularly against

bridge targets in order to avoid hitting civilian settlements on either bank, but traditional bombing runs down the center of the bridge would have been far more effective. In addition, the North Vietnamese soon recognized and began to exploit the United States' unwillingness to risk civilian casualties by moving weapons and equipment shipments in small, hard-to-target shipments, which were then scattered about settled areas for storage.

Finally, the threat of Chinese or Russian entry into the war also limited US operations in North Vietnam. Strikes were prohibited in a 30-mile buffer zone along China's border. The docks at Haiphong harbor, through which most arms entered the country, were off-limits because of the foreign ships docking there. Within North Vietnam, certain targets where Russian agents might be working were also off-limits. Of particular threat to the USAF were the Soviet-built SAM sites under construction all over the target area — allegedly under the supervision of Soviet advisors, and therefore off-limits. However, on 23 July 1965 the US lost a plane to one of these Soviet-built SAM sites, followed by another plane a month later. These losses prompted the US to initiate a series of special missions, code-named "Iron Hand," which specifically targeted the SAMs. Only those near Haiphong harbor and Hanoi remained off-limits.

Diplomatic Stalemates and MiG Encounters

In May of 1965, President Johnson called the first of several ceasefires in an attempt to persuade Viet Cong officials to negotiate a diplomatic peace. The May ceasefire lasted only six days. Several months later, on Christmas Eve of 1965, President Johnson again called a halt to Rolling Thunder operations — this time for about a month, during which it became apparent that the Viet Cong had no intention of negotiating and were using the time to rebuild and resupply. On 30 January 1966, the USAF resumed Rolling Thunder operations with renewed force and began to push northward toward Hanoi.

In September 1966, as they approached the city, USAF forces encountered their first MiG over North Vietnam. By 1967 Washington was approving targets ever closer to Hanoi, pressuring the Viet Cong to field almost 100 MiG interceptors. As US Air Force and Navy losses to air-to-air attacks began to mount, Washington allowed attacks on four of five MiG airfields in North Vietnam. By the end of 1967, combined US forces had downed 75 MiGs in air-to-air combat, with a loss of only 25 of their own aircraft. Hanoi's industrial base was also targeted — including major power plants and railyards, some of which had been previously off-limits due to restrictions against urban operations.

Firing his 20mm cannon at point-blank range, an F-105 pilot hits a MiG's left wing. His F-105 passed 15-20 feet below the flaming MIG (circa 1960-73).

NARA photo NWDNS-342-C-KE26311

An Uneasy Ceasefire

As the North Vietnamese seemed more willing to negotiate, in March 1968 President Johnson limited Rolling Thunder bombing operations to an area just north of the DMZ. Peace talks began in Paris, but as Hanoi officials negotiated, thousands of North Vietnamese troops continued pouring into South Vietnam. The US redoubled its efforts just north of the DMZ, but refrained from venturing further north. With Viet Cong assurances that the incursions into South Vietnam would halt, President Johnson called an end to all air, naval and artillery bombardment of North Vietnam, bringing Rolling Thunder to a permanent end in October 1968.

However, President Johnson's agreement authorized unarmed American aircraft to continue flights over North Vietnam for reconnaissance purposes. When several of these aircraft were attacked, President Nixon authorized retaliatory strikes, but limited targets to air defense sites. In 1971 the US stepped up these retaliatory strikes, expanding the target list to include Viet Cong road construction through the DMZ and oil storage sites south of Hanoi. By the end of that year, the North Vietnamese Air Force was able to field 250 MiGs, which posed a serious threat to US strike fighters. In response, Washington authorized the USAF and USN to bomb three airfields in southern North Vietnam in early November.

The "Thud"

In the first four years of the Rolling Thunder operations, the F-105D Thunder Chief, affectionately nicknamed the "Thud," flew over 75% of the air strikes over North Vietnam. (The immense B-52 Stratofortress strikes widely portrayed in media images of the Vietnam conflict were more representative of later Linebacker Operations.) Designed as a supersonic long-range nuclear bomber, the F-105 could carry a weapons payload of over 12,000lbs. For typical ground strike missions in North Vietnam, it generally carried eight 750lb bombs.

Although primarily a ground attack aircraft, the F-105 proved quite capable of handling itself in an air battle. F-105s aircrews downed 27.5 MiGs during their service in Southeast Asia (one kill was shared with an F-4D Phantom).

The last F-105D was withdrawn from service in the USAF in 1980.

F-105 Thunderchiefs, enroute to a bombing mission in Vietnam, refuel in mid-mission from a KC-135 Stratotanker (ca. 1966).

NARA photo NWDNS-306-MVP-14(28)

Operation Linebacker

In direct response to the Viet Cong invasion of South Vietnam in the spring of 1972, President Nixon broke off peace talks then underway and authorized the US Armed Forces to resume aerial bombardment of North Vietnam through Operation Linebacker. For the first time, US aircraft also mined the Bay of Haiphong and other waterways that had been used throughout the war to ship arms and equipment into the country.

When North Vietnamese officials asked to renew peace talks in October, the US again halted the bombardment. However, as two months passed without resolution to the negotiations, President Nixon ordered the commencement of Linebacker II. On 18 December 1972, the US began its heaviest bombardment of the war. For eleven days, B-52s pounded power plants, broadcast stations, ports, railways, airfields, and military sites in and around Hanoi and Haiphong by day and night. Support fighters saw some of the most intense air combat of the war, mostly against the newer MiG-21s. On 29 December 1972, North Vietnamese agreed to renew negotiations and the bombardment was again limited to the area just north of the DMZ. By 15 January 1973 the US had ceased all bombing in North Vietnam, and a peace agreement was signed a few days later.

F-4E Phantom II

The first F-4E squadron reached USAF bases in Thailand at the end of 1968. Following the invasion of South Vietnam in the spring of 1972, six more squadrons were deployed to Southeast Asia to take part in Operation Linebacker. F-4E Phantom IIs were generally considered ground attack fighters and were used to support bombing missions in a Suppression of Enemy Air Defense (SEAD) role. (Later F-4G "Wild Weasels" would in fact be customized for the SEAD role.) They also prepared target areas for incoming bombers by dropping loads of chaff in order to confuse enemy radar, and they carried out some Linebacker strikes against ground targets that were too well-protected for B-52 bombers to reach. However, they were also used in an escort role to counter enemy MiG threats over North Vietnam.

F-4 pilots attend intelligence briefing at Cam Ranh Bay AB in South Vietnam (December 1968).

NARA photo NWDNS-342-C-KE36967

In this last role, F-4 pilots found themselves at a decided performance disadvantage — North Vietnamese MiG-17s and MiG-21s could out-maneuver the F-4 in a subsonic turning fight. However, the F-4E carried longer-range weapons, and it had been assumed that the new long-range missiles would virtually eliminate the dogfight — indeed, early models of the F-4 had no internal cannon, partly because there was no place for it in the original nose design and partly because it was considered unnecessary.

In practice, though, once the long-range missile opportunity was lost, so was the F-4E's advantage. Unfortunately, these early "high-tech" long-range AIM-7s were notoriously less reliable and more susceptible to malfunctions and countermeasures than the short-range IR-guided missiles and air-to-air guns of the era. In fact, missile fire-to-hit ratios were low and extended MiG encounters generally came down to a close-in dogfight. In addition, MiGs developed tactics to render the American missile advantage moot, favoring surprise hit-and-run attacks from the rear, which gave their rear-aspect missiles their best targets. In all, F-4E aircrews reported 21 MiG kills, included 10 by AIM-7s, 5 by gunfire, 4 by AIM-9s and the remaining 2 by a combination of weapons or maneuvering.

USAF photo

The F-4E's demonstrated versatility kept it in production for twelve years. More F-4Es were built than any other variant. It was later replaced by the F-15 Eagle lineage.

Rescue Operations

The USAF Air Rescue Service (ARS) was established in 1946 for rescue coverage in the continental United States. Although Emergency Rescue Service helicopter units had existed during WWII, the ARS marked the beginning of a force specially trained to develop and execute of search and rescue tactics. In 1966, the ARS was redesignated Aerospace Rescue and Recovery Service (ARRS) to reflect its rescue support role for the US space program.

ARS shield

US Army soldier directs a helicopter recovering injured in South Vietnam (Oct. 1966).

NARA photo NWDNS-342-AF-100573USAF

During the Vietnam Conflict, the ARRS rescued 4,120 people, with 2,780 rescued under combat conditions. A typical rescue unit consisted of a HH-43 Huskie rescue and fire suppression helicopter, accompanied by several A-1E Skyraiders assisting with the search and suppressing enemy ground fire during pickup. Forward Air Controllers (FACs) in O-1 and O-2 helicopters frequently conducted the search leg of rescue operations: locating downed crewmen, marking their location with smoke bombs, calling

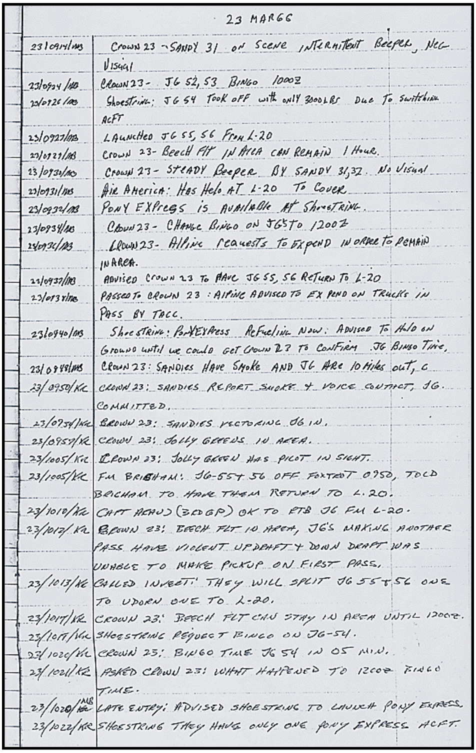
in the rescue flight and directing the Skyraiders in ground suppression once the rescue crew arrived. By the end of the war, the arrival of OV-10 Broncos equipped with PAVENAIL night observation equipment greatly expanded rescue operations at night and in bad weather.

A-1E Skyraider

The Skyraider was modified in 1963 for service in Vietnam. Able to fly for long periods at low altitudes, this slow-flying single-prop aircraft was ideally suited to search and rescue operations. It was able to absorb heavy ground fire and carry heavy bomb loads, and therefore also well-suited to a close air support (CAS) role. In rescue operations, it generally flew escort for rescue helicopters to neutralize ground fire during the pickup. A-1Es were replaced by A-7D Corsair II close air support jets toward the end of the conflict.

HH-43 Huskie

Originally designed for base crash and fire rescue, the HH-43 was initially limited by its combat radius of only 75 miles. Additional fuel drums strapped into the cabin were set up to extend this range, and before newer, longer-range helicopter models were available to the AARS, HH-43s occasionally flew rescue missions deep into North Vietnam. HH-43s could be airborne within one minute, carrying two rescue crewmen trained for emergency rescue and fire suppression. In the event of a fire at the crash site, crewmen used foam from a fire suppression kit attached beneath the helicopter and downwash from the helicopter's rotor blades to clear a path for survivors to escape to a place where they could be safely picked up.


23 MAR66

23/0914/MB	CROWN 23 - SANDY 31 ON SCENE INTERMITTENT BEEPER, NEG VISUAL
23/0924/MB	CROWN 23 - JG 52, 53 BINGO 1000Z
23/0926/MB	SHOESTRING: JG 54 TOOK OFF WITH ONLY 3000 LBS DUE TO SWITCHING ACFT
23/0927/MB	LAUNCHED JG 55, 56 FROM L-20
23/0929/MB	CROWN 23 - BEECH FLT IN AREA CAN REMAIN 1 HOUR.
23/0930/MB	CROWN 23 - STEADY BEEPER BY SANDY 31,32. NO VISUAL
23/0931/MB	AIR AMERICA: HAS HELO AT L-20 TO COVER
23/0932/MB	PONY EXPRESS IS AVAILABLE AT SHOESTRING.
23/0934/MB	CROWN 23 - CHANGE BINGO ON JG5 TO 1200Z
23/0936/MB	CROWN 23 - ALPINE REQUESTS TO EXPEND IN ORDER TO REMAIN IN AREA.
23/0937/MB	ADVISED CROWN 23 TO HAVE JG 55, 56 RETURN TO L-20
23/0938/MB	PASSED TO CROWN 23: ALPINE ADVISED TO EXPEND ON TRUCKS IN PASS BY TACC.
23/0940/MB	SHOESTRING: PONY EXPRESS REFUELING NOW: ADVISED TO HOLD ON GROUND UNTIL WE COULD GET CROWN 23 TO CONFIRM JG BINGO TIME,
23/0948/MB	CROWN 23: SANDIES HAVE SMOKE AND JG ARE 10 MILES OUT, C
23/0950/KR	CROWN 23: SANDIES REPORT SMOKE + VOICE CONTACT, JG. COMMITTED.
23/0954/KR	CROWN 23: SANDIES VECTORING JG IN.
23/0957/KR	CROWN 23: JOLLY GREENS IN AREA.
23/1005/KR	CROWN 23: JOLLY GREEN HAS PILOT IN SIGHT.
23/1005/KR	FM BRIGHAM: JG-55 + 56 OFF FOXTROT 0950, TOLD BRIGHAM TO HAVE THEM RETURN TO L.20.
23/1010/KR	CAPT ACAUD (3RD GP) OK TO RTB JG FM L-20.
23/1012/KR	CROWN 23: BEECH FLT IN AREA, JG'S MAKING ANOTHER PASS HAVE VIOLENT UPDRAFT + DOWN DRAFT WAS UNABLE TO MAKE PICKUP ON FIRST PASS.
23/1013/KR	CALLED INVERT: THEY WILL SPLIT JG 55 + 56 ONE TO UDORN ONE TO L-20.
23/1017/KR	CROWN 23: BEECH FLT CAN STAY IN AREA UNTIL 1200Z.
23/1017/KR	SHOESTRING REQUEST BINGO ON JG-54.
23/1020/KR	CROWN 23: BINGO TIME JG 54 IN 05 MIN.
23/1021/KR	ASKED CROWN 23: WHAT HAPPENED TO 1200Z BINGO TIME.
23/1020/MB	LATE ENTRY: ADVISED SHOESTRING TO LAUNCH PONY EXPRESS.
23/1022/KR	SHOESTRING THEY HAVE ONLY ONE PONY EXPRESS ACFT.

Except from USAF search and rescue log, dated 23 March, 1966. "Sandy" is the radio callsign for an A-1E, the "Jolly Green Giants" are HH-3s and "Crown 23" is a HC-130P tanker orbiting at higher altitudes as an airborne command post.

NARA document NWCTM-342-SRCHRECSCLOG-LOGCROWN23

Desert Storm

History

The Persian Gulf conflict originated in early August of 1990, following a series of unsuccessful talks between Iraq and Kuwait regarding oil pricing. On 2 August 1990, Saddam Hussein, the Iraqi leader, decided to invade Kuwait to commandeer its vast fields of petroleum. Iraqi troops stormed the border, and in a matter of hours, the tiny, defenseless country of Kuwait fell under Hussein's control.

Following this invasion, Iraq gained power over nearly a quarter of the world's rough oil reserves. Saudi Arabia's leaders became worried — with due cause — that their country might be next on Iraq's list of likely targets. Saudi leaders expressed great concern over this invasion and issued a desperate plea for help. The US answered this call for assistance and immediately stepped in to protect its ally.

Operation Desert Shield

Hussein's invasion of Kuwait led to an immediate American economic embargo against Iraq, soon reiterated by the United Nations Security Council. Iraq was ordered to vacate Kuwait, but the embargoes and threats elicited no immediate response. Several days later, on 7 August 1990, then-President George Bush authorized a counteraction called Operation Desert Shield. The goal of this operation was to force the Iraqi troops out of Kuwait and push them back into their home country. To emphasize its commitment to remove Iraqi forces from Kuwait, the UN issued a 15 January 1991 deadline for withdrawal.

The Headquarters U.S. Central Command (CENTCOM) directed the coalition of allied UN forces. Led by Army General H. Norman Schwarzkopf, CENTCOM's function was to manage the deployment of troops into the Persian Gulf. Although Saudi Arabia was the primary country under allied protection, other small Arab countries in the region were under a security watch as well.

While CENTCOM managed the troop deployments, air operations fell under the jurisdiction of Air Force Lt. Gen. Charles Horner. As the supreme air commander, Lt. Gen. Horner created the Headquarters Central Command Air Forces. Located in Saudi Arabia, this forward air base became the pivot point for all air actions. US Air Force and National Guard reservists were activated and brought into the region to handle tactical fighter and supply needs, including airlifts, tanker duty and supply drops. In a 30-day period, 25 fighter squadrons were sent to Riyadh, far outnumbering Iraq's meager air forces.

By Christmas, Saddam Hussein was still refusing to cooperate with the UN Security Council. With the 15 January deadline looming dangerously close, the Council continued to try to resolve the situation without the use of military force. On the 15th, however, Iraq continued to maintain its staunch silence.

True to form, Iraqi president Saddam Hussein continued to ignore the Council's eleventh-hour request. UN forces responded with the first retaliatory strikes early in the morning of the 17th, and Operation Desert Shield became Operation Desert Storm.

Operation Desert Storm

In the early morning hours of 17 January 1991, Apache Longbow helicopters knocked out radar installations across the Iraqi border, effectively clearing a corridor for coalition aircraft and virtually blinding Baghdad. Military targets for the massive first strike included surgical hits on command centers, radar sites and airport facilities. Over 1000 sorties and 10 days and nights later, the coalition's constant barrage of fire had accomplished most of its military objectives. For all intents and purposes, Iraq was crippled — its weapon development programs, air force, surface-to-air missile sites and internal command structures had been destroyed.

Downtown Baghdad: Initial Targets Jan. 1991; from Decisive Force *by Richard G. Davis, U.S. Air Force, 1996*

Available from the online map collection of the Perry Castañeda Library, University of Texas, at www.lib.utexas.edu/Libs/PCL/Map_collection.

An End to War

The degradation of order in Iraq continued to worsen through February 1991. By the end of the month, Saddam Hussein's hungry, distraught Iraqi soldiers began fleeing en masse. A number of Iraqi pilots flew their aircraft into Iran and promptly surrendered. On 27 February 1991, Iraq's military forces were nearly non-existent, and the Kuwaiti leaders were reinstated.

The coalition halted its air attacks in late February. However, the war did not officially end until 11 April 1991, when Saddam Hussein finally signed UN Security Council Resolution #678.

Kuwait's liberation was not all victory and glory, however. Before departing, Iraqi soldiers had set fire to dozens of oil fields. Millions of barrels of petroleum burned day and night, churning up a smoky haze that would take weeks to dispel. The fires were eventually contained, but the damage to the environment was already done.

USAF Auxiliary Support

Throughout the duration of Operation Desert Shield/Storm, over 55,000 Air Force personnel were moved into the Gulf region in active duty. Thousands of other Air Force personnel helped maintain operations with secondary support in the form of supplies, equipment, communications, strategic planning and medical help.

Civil engineers shouldered most of the early work in Operation Desert Shield. They erected over 5,000 tents, constructed a small city of buildings and poured more than 1.5 million square feet of concrete and asphalt to create a fully functional airport.

Fifteen independent air-transportable hospitals with 750 beds each were deployed, along with a larger contingency hospital. To further cover any medical needs, four Air Force contingency hospitals were set up in Europe and over 20 casualty reception hospitals in the United States. Finally, over 5,200 medical personnel traveled into the immediate region to support these hospitals. Although casualties were relatively light compared to Vietnam and other past conflicts, nearly 50,000 patients were treated by the war's end.

USAF Command and Control

Operation Desert Storm was a proving ground for many new command and information assets. The advent of high-end radar, stealth technology and powerful intelligence resources helped identify strategic targets and verify combat results.

One of the most important developments was the implementation of the Global Positioning System used for navigation. Orbiting satellites communicating with ground-based transmitters could accurately pinpoint locations on the Earth's surface within several meters. This system was operational 20 out of 24 hours each day and provided accurate data for navigators and pilots trying to locate targets.

Similarly, the Defense Satellite Communications System used satellites to ensure secure voice and data communication transmissions between over 100 ground-based terminals. This allowed field commanders to send and obtain information more quickly than in any other war.

A smaller but no less important asset, the Defense Meteorological Support system figured heavily into Desert Storm's success — for early 1991 brought the worst weather in 14 years to the Gulf region.

USAF Intelligence Systems

In previous wars, planning a mission could take several days. The primary reason for the delay was the transmission of information between all involved parties. In Desert Storm, however, the Mission Support System allowed Air Force pilots to share integrated mission planning support. Groundwork plans for a mission could be laid out in a few hours instead of

a few days. The system provided commanders and pilots with vital data, including charts, maps and target and threat information. This system emerged as a reliable command and control tool for CENTCOM.

Digital faxes were also an integral part of planning and accomplishing missions. With a tactical digital facsimile, high-resolution pictures and data could be transmitted to all friendly crews and commanders in the battlefield.

In actual combat, the Airborne Warning and Control System (AWACS) was probably the most important intelligence tool. Employed on two E-8 test aircraft, the J-STARS (Joint USAF-Grumman Surveillance Target Attack Radar System) had the ability to locate and track everything that moved on the ground. Alternating days of duty, the E-8 J-STARS collected information about Scud targets, convoys, trucks, SAM sites and artillery sites. This experiment proved highly useful, since the information could then be handed off to other aircraft or to the troops below. J-STARS capabilities were available nearly 80% of the time, keeping most of Iraq well lit under the watchful eye of coalition radar.

Aircraft in the Persian Gulf

The combined firepower that the coalition unleashed during Operation Desert Storm was tremendous. The Air Force alone dropped 90% of all precision-guided weapons and knocked out 36 fixed-wing aircraft and helicopters. From the opening day of the war until the cease-fire, the USAF flew 59% of all missions, provided half of the aircraft for all missions combined, and suffered an attrition rate of 37%. The mission capable rate, at 92%, was quite remarkable.

Combined, Air Force Support aircraft, special operations aircraft and combat aircraft accounted for half of the aircraft in all coalition missions. Due to advances in stealth technology and weapon systems, many enemy aircraft and tactical targets were destroyed, but few coalition aircraft were lost.

The next sections discuss various Air Force aircraft and their contribution to the war effort. (For additional information on aircraft, please see **Aircraft Specifications**, p. 7.1.)

Support Aircraft

The tactical deployment of aircraft into the Persian Gulf was larger than any deployment since World War II. The Air Force moved in nearly half a million troops and over half a million tons of cargo. US Air Force C-5 and C-141 aircraft carried most of the cargo; commercial aircraft transported most troops and the rest of the cargo. Almost all C-5s and C-141s in service were assigned to Desert Shield/Storm, though a few handled missions elsewhere in the world. The commercial aircraft were brought into duty as part of the Civil Reserve Air Fleet, an airlift arm of the Department of Defense. In its first "tour of duty," the civilian-run CRAF contributed 95 passenger and 63 cargo aircraft to military operations in the Gulf.

Nearly 150 C-130s were also deployed to support Operation Desert Shield/Storm and amassed nearly 50,000 sorties during the course of the war.

Their primary duties were to haul troops and supplies to forward air bases, while also providing logistical support and medical evacuation.

Over 250 KC-135 and nearly 50 KC-10 aircraft flew into the Persian Gulf to provide refueling points for aircraft in all service branches. Together, they refueled fighters, bombers, AWACS and J-STARS.

KC-135 refuels F-16 formation. *USAF photo*

Special Operations Aircraft

Air Force Special Operations Command units involved in Desert Storm flew a vast array of crucial missions. These aircraft sorties had a variety of mission objectives, including infiltrating enemy lines, performing direct assault actions, rescuing downed pilots, dropping bombs and accomplishing counter-terrorist missions.

MH-53J *USAF photo by Senior Airman Richard M. Heileman*

Many special operations aircraft consisted of AC/EC/MC/HC-130 Aircraft and MH-53J Pave Low helicopters. These aircraft flew over 830 missions in support of CENTCOM and provided valuable intelligence information. Some, such as the MH-53J Pave Low and AH-64 Apache Longbow, also played a vital role during the opening hours of the war.

Combat Aircraft

When the conflict in the Persian Gulf began, coalition air forces faced 750 Iraqi combat aircraft and 200 support aircraft, not to mention Scud surface-to-surface missiles, air defenses and chemical/biological weapons. The Iraqi air force had 24 operational airbases, all fortified with hardened aircraft shelters. It didn't take long, however, for the coalition forces to destroy the Iraqi air force.

Operations Desert Shield and Desert Storm employed dozens of types of aircraft. Numerous combat fighters and bombers saw action in the region, including the F-15E Strike Eagle, the F-15C/D Eagle, the A-10 Thunderbolt II, the F-117 Nighthawk, the B-52 Stratofortress, the F-111F Aardvark, the EF-111S Raven, the F-4G Wild Weasel and the F-16 Fighting Falcon.

The F-15C/D was the most successful air-to-air killer in the Gulf. It was involved in over 5,900 sorties and was solely responsible for taking down every Iraqi fixed-wing aircraft lost in the conflict. Meanwhile, the F-15E was used primarily to root out Scud missile sites and hardened targets at night.

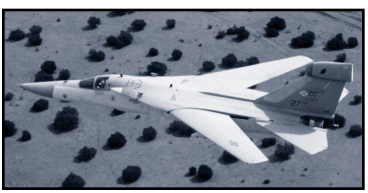
The Strike Eagle was responsible for successful hits on a number of Iraqi armor columns and command and control centers. The most successful air-to-ground combat aircraft was undeniably the A-10A Thunderbolt II. While flying only 30% of the Air Force's missions, the A-10A destroyed half of all confirmed Iraqi equipment losses and fired off nearly all of the Air Force's guided Maverick missiles. A versatile and maneuverable aircraft, the A-10A flew over 8,000 sorties and established itself as a daytime Scud hunter.

A-10A fires a AGM-65 Maverick. *USAF photo*

Strategic targets close to the heart of Iraq were the responsibility of the USAF's stealth fighter, the F-117 Nighthawk. Silently flying over 1,250 sorties and bypassing Baghdad's air defense systems, F-117s took advantage of their stealthy approach and destroyed valuable communication and military sites with minimal collateral damage.

The trusty B-52 Stratofortress reestablished itself as a hefty tool of destruction during the Gulf War. B-52s flew over 1,600 missions and released 72,000 weapons against large targets — airports, industrial plants, and storage facilities. The hits were more accurate than in past conflicts, probably due to an increased ability to locate the correct target. These bombers dropped nearly half of the Air Force's bombs over the course of the war.

Using its Forward-Looking Infrared Radar (FLIR) and laser designation abilities, the F-111F Aardvark was a prime candidate to take out many target types. Many chemical, biological and nuclear sites fell victim to F-111Fs, as did airfields, bunkers, comm sites and air defense systems. Despite facing a number of dangerous targets, only one F-111F was damaged.



EF-111A Raven *USAF photo by Master Sgt. Dave Nolan*

Though they played a smaller role, EF-111A Ravens were a crucial part of the coalition's success in Operation Desert Storm. By employing radar jamming, they were able to temporarily blind Iraqi air defense sites long enough for other Air Force fighters to move in for the kill. One such fighter was the F-4G Wild Weasel, which carried high-speed anti-radar (HARM) missiles that could easily knock out an active radar site. In fact, the F-4Gs were so successful that in many cases, the Iraqis did not dare risk to turn on their radar for more than a few seconds at a time.

Finally, the F-16 Fighting Falcon was one of the Air Force's most versatile aircraft. Numbering just under 250, they flew an impressive 13,450 sorties — more than any other USAF aircraft. Many of these missions concentrated attacks on Scud missile launchers, though military production and support facilities were hit as well.

Operation Red Arrow

The Operation Red Arrow campaign and the Red Flag training missions are based on the USAF's advanced combat training program, known as Red Flag. Red Flag exercises are designed to take the skills that pilots and aircrew learn in basic and weapon training and apply them to combat situations in which information must be shared and maneuvers coordinated among all elements of a team, and split-second decisions must be accurately made amidst the confusion of battle. The need for this type of field training, in addition to advanced weapon training, became apparent during the conflict in Vietnam.

The Need for Advanced Combat Training

It was an easy assumption to make: as air-to-air missile technology became more and more sophisticated, aerial offensive/defensive maneuvers would quickly become obsolete. Prior to the conflict in Vietnam, most imagined that in the future of air combat, a pilot would spot his opponent from a distance, lock on, launch missiles, and continue with the mission unimpeded as the bandit fireballed to the ground. Classic dogfighting training was de-emphasized in favor of weapons training — prior to the Vietnam conflict, only the US Navy's F-8 Crusader pilots had received any advanced combat maneuver training. In fact, the assumption that missile warfare had replaced the up-close gun battle was so great, that the early model F-4s flown over Vietnam even lacked internal guns.

However, the long-range AIM-7 Sparrows of the Vietnam era were often unreliable and ineffective. And since the rules of engagement at the time required a visual ID, pilots were forced to further decrease missile effectiveness by firing at shorter ranges than those for which the missiles had been designed. Once they lost the missile advantage, US pilots found themselves engaged in close aerial combat with guns and short-range, rear-aspect missiles. Since the North Vietnamese MiGs could for the most part meet or exceed American aircraft performance in close maneuvers, air battles often came down to skill alone.

The overall air-to-air exchange ratio in Vietnam was low — 2.5 enemy pilots downed for every American pilot, compared to 8 to 1 during WWII and 14 to 1 over Korea. It became obvious that those F-8 squadrons that had received advanced air combat training significantly outperformed squadrons that had not. The importance of advanced air combat training hit home, and both the USAF and USN established programs designed to train pilots to effectively use their high-tech weapons and weapons training in simulated battlefield situations. The Air Force's premier combat training program, Red Flag, began in 1975 and was designed by the late Col. Richard "Moody" Suter.

Red Flag Today

In Red Flag missions, pilots-in-training are part of the "Blue" forces. They are sent out on combat maneuvers against mock airfields, missile sites and other common targets. More experienced personnel make up the opposition "Red" forces; they are tasked with simulating enemy air force maneuvers and anti-air doctrine. Red ground forces man anti-aircraft artillery and SAM sites, providing pilots the opportunity to learn how to avoid being shot down while successfully completing a mission. In addition, Blue force pilots face heavy opposition from the Red Air Force — expert pilots who have been trained to use F-16C aircraft to simulate the tactics and techniques new pilots will most likely have to defend against.

An important element of the overarching Red Flag training procedure is the Measurement and Debriefing System. Through this system, each pilot's mission is monitored and later reconstructed, allowing instructors to pinpoint mistakes and suggest alternatives.

Currently more than a thousand pilots go through each intensive two-week Red Flag training session. Most are American, although other NATO allies are also included. The primary "base of operations" is 12,000 miles of desert near Nellis AFB, just outside Las Vegas, Nevada.

As the motto goes, Red Flag is where "the Air Force's Best Get Better."

Two F-16Cs painted and piloted as "MiG" aircraft of the Red Air Force during Red Flag training exercises over Nellis AFB.

USAF photo by Senior Airman Brett Snow

Operation Sleeping Giant

Jane's Defence Weekly

07 October 1995 Volume 024 / Issue 014 / Page 3

NATO Acts on CFE Complaint

NATO has moved to counter Russia's proposal that it be allowed to keep higher levels of equipment in its northern and southern flanks than mandated in the Conventional Armed Forces in Europe (CFE) treaty.

A new plan, tabled at the CFE's Joint Consultative Group (JCG) in Vienna, includes "no numerical change in the flank numerical limits", said John Holum, head of the US Arms Control and Disarmament Agency. Russia "would still have to make substantial reductions," noting that Moscow has already destroyed more than 10,000 pieces of treaty-limited equipment.

The proposal would essentially "remove rearward" political subdivisions in both the flanks that do not directly adjoin sensitive borders with Norway and Turkey. The effect is that the overall numerical limits of allowed equipment in the flanks would not change. However, the land mass in which they would be allowed would be smaller. This would result in Russia redistributing its treaty-limited equipment in the areas that concern it the most.

Russia's complaint is that the 1990 CFE treaty limits punish it unfairly since the treaty was negotiated with the Soviet Union. Since then, Russia has sought amendments to the treaty changing its allowable limits of conventional weapons in both its northern and southern flank regions. Warfare in Chechnya and unrest in the Caucasus have also increased Russian interest in changing the treaty.

As a trade-off for these NATO changes Russia would have to agree to additional exchanges of information, inspections, and "additional equipment restraints in certain areas", says Holum. These efforts would provide additional security reassurances to Norway and Turkey.

NATO believes its new plan could be approved by the JCG without amending the treaty, as the original maps that spelled out the flanks and subdivisions were not formally part of the treaty.

Jane's Intelligence Review — Pointer

01 October 1998 Volume 005 / Issue 010 / Page 7

Discontent Grows in Russia

Labour unrest in Russia continues to grow. According to the then Russian Deputy Prime Minister Boris Nemtsov, the government will withhold cash from coal-mining industries in any region where unpaid miners were blocking the rail lines. In addition, he stated that the government will disregard any demands from miners who resorted to unlawful forms of protest, such as blocking the railways. Despite these statements, the leader of the political

arm of Russia's Federation of Independent Trade-Unions threatened to launch a nationwide strike in protest over unpaid wages and a government-austerity plan drawn up as a condition of a bail-out by the International Monetary Fund. Union leaders will meet in September to convince its members to begin an indefinite strike on 7 October.

However, there are some small signs of improvement in the labour situation. Miners on the island of Sakhalin called a halt to a two-week blockade of the main regional power plant. This improvement may be short-lived; local government employees (such as teachers and doctors) who are also demanding their wages will join the miners in again blockading the power station if the government cannot find a way to pay backwages.

In other areas of the country, labour unrest has spread to other sectors of the work force. For instance, in Vladivostok, ambulance crews were on strike for the third day as Pointer went to press, in protest of the fact that they have not been paid for the last four months. Currently, only four ambulance teams are working in Vladivostok, a city of 650,000 people, and they will only respond to calls in which a life-saving procedure must be performed.

Frontline: Eastern Europe

07 February 2000 Volume 27 / Issue 005 / Page 35

Military Behind Damidov — People Next?

Although immense civil discontent over Russia's recurrent economic crises and ever-expanding organized crime webs had analysts in the West predicting an imminent Russian coup for years, all were caught off guard when the coup actually occurred. The leader of the coup, former Russian Air Force Commander Sergey Damidov, was by no means unknown in the West, but his intention to mount a large-scale coup against the democratic Russian leadership was an extremely well-kept secret.

In retrospect, it appears that Damidov had been quietly planning the coup for years, taking steps and making deals necessary to guarantee his success without suggesting to anyone other than a few trusted advisors that he was planning a coup. Certainly his rank in the military, itself one of the hardest-hit sectors of the Russian economy, guaranteed him a hierarchical network of supporters — and perhaps the only such network well-armed enough to thwart mafia opposition to January's coup. Since the coup, Damidov has made efforts to reward the military for this support, delivering at least some of the back payment owed soldiers and promising a renewed Russia rebuilt on a strong military base.

Although Damidov has made similar pledges of security and prosperity to the general populace, it remains to be seen how stable his base of support outside the military will remain.

Frontline: Eastern Europe

18 May 2000 Volume 27 / Issue 18 / Page 17

Damidov Initiates Reforms

Sergey Damidov's New Communist Party (NCP), created shortly after he took control of the Russian central government on 5 January 2000, appears to be modeled very closely on some of the more repressive regimes of its forerunner. Within a few months of its creation, it revived the Stalinist Five-Year Plan, calling for increased military and infrastructure spending, to be funded by decreases in other government spending. In support of the program, Damidov has promised Russians that although short-term sacrifices may be great — cutting already minimal social services down to nearly nothing — in the long-term, a military buildup will create jobs and stabilize wages. And unlike the late democratic regime, Damidov has announced that the NCP will guarantee all workers jobs. He promises that if they work together through these lean years to rebuild Russia, then Russia will be in a position to re-institute health care, education, retirement pensions, and other social support systems once guaranteed all Russians.

Due to recent limitations on the press, it is difficult to ascertain exactly what the average citizen thinks of the NCP regime. Official NCP press releases and broadcasts quote Russian relief that the country is finally united behind a common project, and cite the discipline and goals of the Five-Year Plan as reassuring. And indeed, after nearly a decade of plummeting wages and vanishing services with no goal in sight, this might certainly be the case.

Frontline: Western Europe

21 June 2004 Volume 27 / Issue 23 / Page 2

NATO Rushes to Counter Invasion

Caught off guard by Russia's 6 June invasion of Poland, the Czech Republic and Germany, NATO hurriedly prepares its counteroffensive. Although Russia appears to have temporarily halted its advancement into western Germany, the situation there remains extremely tense. As native German forces struggle to gear up to full combat readiness arms, equipment and troops from NATO allies pour into German bases. Although Germany has no shortage of personnel, this lightning buildup of force has stretched supplies to the limit, and NATO support of the ground force has focused on meeting the most immediate logistical demands of equipment and weaponry. Meanwhile, the US Air Force has deployed squadrons to airbases in West Germany to provide air support for the ground force buildup and offset further Russian expansion.

USAF aircraft fly by a castle near Spanghelm AFB in Germany.
USAF photo by Senior Master Sgt. Rose Reynolds

7 AIRCRAFT SPECS

Previous page: Two F-15Es in formation with a MiG-29. USAF photo.

Chapter 7

AIRCRAFT SPECS

The descriptions and specifications in this section were taken from the *Military Aircraft — Fixed Wing* section of the 1997 and later editions of *Jane's All The World's Aircraft.* Due to space constraints, the descriptions and/or statistics have been abridged. All British spellings have been preserved.

DEFINITIONS

The following statistical information is provided for each plane, if available:

Approach speed. Maximum speed at which the airplane can land without crashing (in knots).

Combat radius. Distance an aircraft can fly from base with enough fuel remaining to return (in nautical miles).

G limit. Structural limit of G-force the aircraft can withstand (in units of G).

Height. Measured from ground to highest point on tailplane or fuselage (in meters).

Hover ceiling. (For helicopters) The maximum height (in meters) at which a hover can be maintained.

Internal weapons load. Maximum weight of ordnance carried inside aircraft's weapons bay (in kilograms).

Length. Measured from nose to tail at longest point on fuselage (in meters).

Max dive speed. Maximum speed safely attained during a downward dive. (Additional airspeed may cause structural damage.)

Max external fuel capacity. Weight of fuel held by external tanks attached to hardpoints (in kilograms).

Max internal fuel capacity. Weight of fuel held by internal fuel tanks (in kilograms).

Max landing weight. Limit at which aircraft can make a safe landing (in kilograms).

Max level speed. Maximum speed achieved by the aircraft's power plant alone (i.e., not accelerated by diving, etc.); varies by altitude (in knots).

Max payload. In military aircraft, loosely used to mean total load (weight) carried of weapons, cargo, or other mission equipment (in kilograms).

Max power loading. Aircraft weight divided by total propulsive power or thrust at takeoff (in kilograms per kilo Newton).

Max rate of climb at S/L. Maximum rate of climb attainable at sea-level (in meters per minute).

Max weapons load. Maximum weight of ordnance loaded after aircraft is loaded with full internal fuel and avionic equipment (in kilograms).

Max wing loading. Aircraft weight divided by wing area (in kilograms per meter squared).

Never exceed speed (V^{NE}). Aerodynamic or structural velocity limit (in knots).

Normal max operating speed. Normal speed beyond which the aircraft is not flown (in knots).

Normal/Max takeoff weights. Limit to which an aircraft can be loaded and still take off (in kilograms).

Operational weight empty. Aircraft weight including weight of all necessary avionic equipment (in kilograms).

Range, hi-low-hi and hi-hi-hi. The distance an aircraft can fly under specified conditions (in nautical miles). Hi-hi-hi and hi-low-hi refer to different types of runs: hi-low-hi means an aircraft approaches the target at a high altitude, sweeps low, and then returns to base at high altitude; on a hi-hi-hi run the aircraft maintains a constant high altitude.

Service ceiling. The height equivalent to the air density at which the maximum attainable rate of climb (100ft/min) occurs (in meters).

Stall speed. Speed at which aircraft's wings no longer generate enough lift to keep the plane in the air (in knots).

Takeoff/landing run. Distance necessary for aircraft to take off or land safely (in meters).

Takeoff speed at normal combat weight. Initial speed necessary to lift aircraft off the ground (in knots).

Weight empty. Weight of aircraft without crew, fuel, cargo, and ordnance (in kilograms).

Wheel track. Distance between mainwheels, measured from centre of each wheel (in meters).

Wheelbase. Minimum distance from centre of nosewheel or tailwheel to line joining mainwheels (in meters).

Wing area, gross. Total projected area of clean wing (no flaps, slats, etc.) including all control surfaces and area of fuselage bounded by leading- and trailing-edges projected to centreline (in meters squared).

Wing aspect ratio. Measure of wing slenderness as seen in cross-sectional view; square of the *wing span* divided by the gross area (as a ratio).

Wing span. Distance between wingtips (in meters).

FLYABLE AIRCRAFT

Fairchild Republic A-10 Thunderbolt II "Warthog"

Type

Single-seat close support aircraft.

USAF photo

Programme

Fairchild Republic and Northrop each built two prototypes for evaluation under the US Air Force's A-X programme, initiated in 1967, for a close support aircraft. The first Fairchild Republic prototype (71-1369), designated YA-10A, flew for the first time 10 May 1972. It was announced 18 January 1973, that Fairchild was the winner of the competitive evaluation of the prototypes, and received a contract for six A-10A DT and E aircraft, the first of which flew 15 February 1975.

The first flight by a production A-10A Thunderbolt II (75-00258) was made 21 October 1975. Purchase of a total of 739 aircraft was planned (including the six DT and E aircraft), but funding was terminated in 1983 after a total of 713 production A-10s had been ordered. Delivery was completed 20 March 1984. There were still 327 aircraft in service with the USAF, USAF Reserve, and ANG in early 1994. The Thunderbolt II was used during the Gulf War of 1991.

Export versions of the A-10 were available as single-seat night attack and two-seat combat-ready trainer aircraft. Night capability is provided by the addition of a Westinghouse WX-50 radar, Texas Instruments AAR-42 FLIR, Litton LN-39 inertial navigation system, Honeywell APN-194 radar altimeter, AiResearch digital air data computer, Ferranti 105 laser rangefinder, and Kaiser head-up display.

It is expected that night/adverse weather capability can be improved with the addition of a LANTIRN (low-altitude navigation targeting infrared for night) fire control pod.

The first combat-ready A-10A wing was the 345th Tactical Fighter Wing, based at Myrtle Beach, South Carolina, to which deliveries began in March 1977.

Design Features

Cantilever low-wing monoplane, with wide chord, deep aerofoil section (NACA 6716 on centre-section and at start of outer panel, NACA 6713 at tip) to provide low wing loading. Incidence -1°. Dihedral 7° on outer panels.

Flying Controls

Wide span ailerons made up of dual upper and lower surfaces separate to serve as airbrakes. Flaps, airbrakes and ailerons actuated hydraulically. Ailerons pilot-controlled by servo tab during manual reversion. Small leading-edge slat inboard of each mainwheel fairing. Redundant and armour-protected flight control system. Interchangeable elevators, each with an electrically operated trim tab. Rudders and elevators actuated hydraulically.

Structure

Aluminum alloy three-spar structure, consisting of one-piece constant-chord centre-section and tapered outer panels with integrally stiffened skins and drooped (cambered) wingtips. Outer panel leading-edges and core of trailing-edges are of honeycomb sandwich.

Landing Gear

Menasco retractable tricycle type with single wheel on each unit. All units retract forward, and have provision for emergency gravity extension. Interchangeable mainwheel units retract into non-structural pod fairings attached to the lower surface of the wings.

Power Plant

Two General Electric TF34-GE-100 high bypass ratio turbofan engines, each rated at 40.3kN, enclosed in separate pods, each pylon-mounted to the upper rear fuselage at a point approximately midway between the wing trailing-edges and the tailplane leading-edges. Fuel is contained in two tear-resistant and self-sealing cells in the fuselage, and two smaller, adjacent integral cells in the wing centre-section. Maximum internal fuel capacity 4853kg.

Accommodation

Single-seat enclosed cockpit, well forward of wings, with large transparent bubble canopy to provide all-round vision. Bulletproof windscreen. Canopy is hinged at rear and opens upward. Douglas ejection seat operable at speeds of 450 knots down to zero speed at zero height. Entire cockpit structure is protected by an armoured 'bathtub' structure of titanium, capable of withstanding projectiles up to 23mm calibre.

Armament

General Electric GAU-8/A Avenger 30mm seven-barrel cannon, mounted in nose with 2° depression and offset slightly to port so that as the barrels rotate the firing barrel is always on the aircraft's centreline. Gun and handling system for the linkless ammunitions are mechanically synchronised and driven by two motors fed from the aircraft's hydraulic system. The single drum magazine has a capacity of 1350 rounds, and has a dual firing rate of either 2100 or 4200 rds/min. Four stores pylons under each wing (one inboard and three outboard of each mainwheel fairing), and three under fuselage, for max external load of 7.257kg. External load with full internal

fuel is 5482kg. The centreline pylon and the two flanking fuselage pylons cannot be occupied simultaneously. The centreline pylon has a capacity of 2268kg; the two fuselage outer pylons and two centre-section underwing pylons 1587kg each; the two innermost outerwing pylons 1134kg each; and the four outermost wing pylons 453kg each. These allow carriage of a wide range of stores, including 28,226kg Mk 82 LDGP general purpose bombs; eight BLU-1 or BLU-27/B Rockeye II cluster bombs, 16 CBU-52/71, 10 AGM-65A Maverick missiles; Mk 82 and Mk 84 laser-guided bombs; Mk 84 electro-optically guided bombs; two SUU-23 pods; chaff or other jammer pods; or up to three drop tanks.

Specifications

Dimensions (External)

Wing span	17.53m
Wing aspect ratio	6.54
Length	16.26m
Height	4.47m
Tailplane span	5.74m

Weights and Loadings

Weight, empty	9183kg
equipped, "clean"	10,600kg
Operating weight, empty	10,710kg
Max takeoff weight	21,500kg
Max wing load	449.88kg/m^2
Thrust/weight ratio	0.6

Performance[1]

Never exceed speed	450 knots	
Max combat speed		
at S/L, 'clean'	390 knots	
at 1525m, with six Mk 82 bombs	385 knots	
Cruising speed,		
at S/L	300 knots	
at 1525m	342 knots	
Stabilised 45° dive speed[2]	260 knots	
Max rate of climb[3],	1828m/min	
Mission radius,		
CAS and escort[4]	250nm	
Reconnaissance	400nm	
Deep strike	540nm	
Takeoff distance		
at max takeoff weight		1372m
at forward airstrip weight		426m
Landing distance		
at Max takeoff weight		762m
at forward airstrip weight		382m

[1] At max takeoff weight except where indicated.

[2] Below 2440m, AUW of 5,932kg.

[3] At sea level, for basic design weight.

[4] 2h loiter, 20 min reserves

F-105D/F Thunderchief

NARA photo NWDNS-342-C-K21362

Type

Single-seat close-support aircraft (F-105D).

Two-seat dual-purpose trainer/tactical fighter (F-105F)

Programme

The F-105 was developed to meet USAF requirements for a supersonic single-seat fighter-bomber able to deliver nuclear weapons and heavier loads of conventional bombs and rockets, at very high speeds and over long ranges. Design work began in 1954. The first of these two Y F-105A prototypes began in 1954. The first of these flew on 22 October 1955, followed by 75 F-105Bs, 3 J F-105Bs and later production versions as follows.

Variants

YF-105A. The first of two Y F-105As exceeded Mach 1 during its initial test flight on October 22, 1955, powered by a Pratt & Whitney J57 turbojet engine.

F-105B. Single-seat day fighter-bomber with Pratt & Whitney J75-P-3 or -5 turbojet engine (6,810kg st dry, approx 11,350kg with afterburner). Introduced swept-forward air intakes. The first example of this developed version flew on May 26, 1956, and was delivered to the USAF Flight Test Centre shortly afterwards. The first production aircraft was delivered to USAF Tactical Air Command on May 27, 1958. The 335th Tactical Fighter Squadron, Fourth Tactical Fighter Wing, Eglin AFB, Florida, was first squadron to be equipped with F-105B. Production was completed in 1959 in favor of F-105B. Production was completed in 1959 in favor of F-105D after 75 had been built.

JF-105B. Three aircraft of initial test batch of 15 were started as R F-105B's with cameras in nose. When this role was dropped, they were redesignated J F-105B special tests. The first of them flew for the first time on July 18, 1957.

F-105D. Single-seat all-weather fighter-bomber with Pratt & Whitney J75-P-19W turbojet, NASARR monopulse radar system and Doppler for night or bad weather operation. NASAAR provides all radar functions for both low and high level missions — air search, automatic tracking, ground mapping and terrain avoidance. First F-105D flew on June, 9, 1959, and deliveries to the 4th Tactical Wing began in May 1960. Over 600 built. Max takeoff weight 23,832kg. Max level speed Mach 1.11 at sea level, Mach 2.1 above 11,000m.

F-105F. Two-seat multi-purpose trainer/tactical fighter version of F-105D. Only major design changes are in an increase in the length of the fuselage and a proportionate increase in the height of the tail fin. Unspecified number ordered for USAF in Autumn of 1962, in lieu of equal, number of F-105Ds, for service with all F-105D units. First F-105F flew for the first time on June 11, 1963. (The following descriptions apply to the F-105F.)

Landing Gear

Hydraulically-retractable tricycle type, with single wheel on each unit. Main units retract inward into thickened area of wing-roots created by main air intake ducts. Nose-wheel retracts forward.

Power Plant

One Pratt & Whitney J75-P-19W turbojet engine (12,030kg st with water injection and afterburning). Fuel in three flexible tanks in fuselage forward, main, and aft) with total capacity of 2,9125 litres and one 1,477 litre bomb-bay tank.

Equipment

General Electric FC-5 flight-control system connects with AN/APN-131 Doppler for automatic navigation. AN/ARC 70 UHF radio. AN/ASG-19 "Thunderstick" integrated armament control system consisting of NASAAR radar, General Electric automatic lead computing sight, toss-bomb computer, and associated equipment.

Armament

Fixed armament consists of one General Electric M-61 20mm Vulcan automatic multi-barrel gun with 1,029 rounds. Typical alternative loads are (1) 650 gal centre-line tank, 450 gal tank on one inner wing pylon, nuclear store on the other pylon; (2) 650 gal centre-line tank and four GAM-83B Bullpup nuclear missiles; (3) 450 gal tanks on centre and inner wing pylons, nuclear weapon in bomb-bay; (4) 650 gal centre-line tank, two 3,000lb bombs on inner wing pylons; (5) 650 gal centre-line tank, two 450 gal tanks on inner wing pylons, four Sidewinder missiles on outer-wing pylons; (6) Three rocket packs on centre-line, two on each outer pylon; or (7) Nine BLU-1/B fire-bombs or MLU-10/B mines in similar arrangement to rocket packs, or sixteen leaflet bombs, 750lb bombs, or MG-1 toxic bombs.

Specifications

Dimensions (External) (F-105F)

Wing span	10.65m
Length	21.06m
Height (over tail)	6.15m

Areas (F-105F)

Wing area, gross	35.77m^2
Rudder	1.06m^2

Weights and Loading

Weight empty	12,879kg
Max takeoff weight	24,495kg

Performance (F-105F)

Max level speed	
at 11,600m	Mach 2.25
at S/L	Mach 1.25
Max cruising speed	Mach 0.95
Stall speed	155 knots
Rate of climb at S/L	9,750m/min
Range with max fuel	3,330km

Lockheed F-117A Nighthawk

Type

Precision attack aircraft with stealth elements, optimised for radar energy dispersion and low IR emission.

USAF photo by Technical Sgt. Jack Braden

Programme

Production complete; details of development and early service appeared in the 1993-94 and earlier Jane's. Navalised F-117N proposal described separately.

Design Features

Multi-faceted airframe designed to reflect radar energy away from originating transmitter, particularly downward-looking AEW aircraft; vortexes from many sharp edges, including leading-edge of wing, designed to form coordinated lifting airflow pattern; wings have 67° 30' sweepback, much greater than needed for subsonic performance, with aerofoil formed by two flat planes underneath and three on upper surface; forward underwing surface blends with forward fuselage; all doors and access panels have serrated edges to suppress radar reflection; internal weapons bay 4.7m long and 1.75m wide divided longitudinally by two lengthwise doors hinged on centreline; boom refuelling receptacle on port side of top plate, aft of cockpit. Frontal radar cross-section estimated as 0.01m^2.

Landing Gear

Tricycle type by Menasco, with single wheels all retracting forward. Loral brakes (steel originally, being replaced by carbon/carbon), wheels (F-15E size) and anti-skid system. Goodyear tyres. All doors have serrated edges to suppress radar reflections. Emergency arrester hook with explosively jettisoned cover; Pioneer Aerospace braking parachute (black).

Power Plant

Two 48.0kN (10,800lb st) class General Electric F404-GE-F1D2 non-augmented turbofans. Rectangular overwing air intakes with 2.5 x 1.5 cm heated grid for anti-icing and low observability. Auxiliary air intake doors in horizontal surface immediately to the rear. Part of cold air ingested bypasses engine and is mixed with exhaust gases for cooling. Narrow-slot 'platypus' exhausts, designed by Astech/MCI, in rear fuselage, 1.65m long and 0.10m high, with extended lower lip, surrounded by heat tiles of type used on Space Shuttle and with 11 vertical, internal guide vanes. Sundstrand air turbine starter. In-flight refuelling receptacle in decking aft of cockpit, illuminated for night refuelling by lamp at apex of cockpit. Optional drop tank on internal weapons pylon.

Accommodation

Pilot only; McDonnell Douglas ACES II zero/zero ejection seat. Five Sierracin/Sylmar Corporation individually framed flat-plate windows, including single-piece windscreen. Transparencies gold-coated for radar dissipation. Canopy hinged to open upward and backward.

Systems

AiResearch environmental control, auxiliary power and emergency power systems.

Avionics

Forward-looking infrared (FLIR) sensor, with dual fields of view, in recessed emplacement, covered by fine mesh screen, below windscreen. Retractable downward-looking DLIR and laser designator beneath forward fuselage to starboard of nosewheel bay; FLIR and DLIR by Texas Instruments (to be replaced by improved equipment during third-phase retrofit in 1994). HUD based on Kaiser AN/AVQ-28; large head-down display for FLIR imagery flanked by two multi-function CRTs. Retractable radio antennae beneath fuselage, ahead of port main landing gear, and on spine. Honeywell radar altimeter, Honeywell SPN-GEANS INS (replaced by Honeywell H-423/E ring laser gyro from August 1991; Rockwell Collins GPS to be added); IBM AP-102 mission computer (replacing original three Delco M362F computers); GEC-Marconi flight control computer/navigation interface and autopilot computer (NIAC) system; SLI Avionic Systems Corporation expanded data transfer system and AHRS. Harris Corporation digital moving map added as retrofit with full-colour MFDs.

Armament

Full range of USAF tactical fighter ordnance, principally two 2000lb bombs: BLU-109B low-level laser-guided or GBU-10/GBU-27 laser-guided glide weapons; alternatively, AGM-65 Maverick or AGM-88 HARM ASMs. Provision for AIM-9 Sidewinder (against AWACS aircraft). Internal carriage on two extendible beams in weapon bay. (Only missiles with seeker heads extended below aircraft prior to launch; bombs released from within weapons bay.)

Specifications

Dimensions (External)

Wing span	13.20m
Length	20.08m
Height	3.78m

Weights and Loadings

Weight empty (estimated)	13,381kg
Max weapons load (internal)	2268kg
Max takeoff weight	23,814kg

Performance[1]

Max level speed	561 knots
Max operating speed	Mach 0.9
**Takeoff speed at normal combat weight*	165 knots
**Landing speed*	150 knots
Mission radius[2]	570nm
G limit	+6
Max level speed	561 knots

[1] An asterisk (*) indicates statistics not confirmed by the US Air Force.

[2] Unrefuelled, 2268kg weapon load

Boeing (McDonnell Douglas) F-15C/D Eagle

USAF photo by Senior Airman Greg Davis

Type

Twin-turbofan air superiority fighter; secondary attack role.

Programme

First flight of Y F-15 27 July 1972; first F-15C (78-468) 26 February 1979; first F-15D 19 June 1979; P&W F100-PW-220 standard since 1985; last of 894 F-15A/B/C/Ds delivered 3 November 1989; production restarted during 1991 to produce five for Israel and 12 for Saudi Arabia; production now concentrated on F-15E.

Design Features

NACA 64A aerofoil section with conical camber on leading-edge; sweepback 38° 42' at quarter-chord; thickness/chord ratio 6.6% at root, 3% at tip; anhedral 1°; incidence 0°. Twin fins positioned to receive vortex off wing and maintain directional stability at high angles of attack. Straight two-dimensional external compression engine air inlet each side of fuselage. Air inlet controllers by Hamilton Standard. Air inlet actuators by National Water Lift.

Structure

Wing based on torque box with integrally machine skins and ribs of light alloy and titanium; aluminum honeycomb wingtips, flaps and ailerons; airbrake panel of titanium, aluminum honeycomb and graphite/epoxy composites skin.

Landing Gear

Hydraulically retractable tricycle type, with single wheel on each unit. All units retract forward. Cleveland nose and main units, each incorporating an oleo-pneumatic shock absorber. Nosewheel and tyre by Goodyear, size 22 x 6.6-10, pressure 17.93 bars. Mainwheels by Bendix, with Goodyear tyres size 34.5 x 9.75-18, pressure 23.44 bars. Bendix carbon heat-sink brakes. Hydro-Aire wheel braking skid control system.

Power Plant

Two Pratt & Whitney F100-PW-220 turbofans, each rated at 105.7kN with afterburning for take-off. Internal fuel in eight Goodyear fuselage tanks, total capacity 7836 litres. Simmonds fuel gauge system. Optional conformal fuel tanks attached to side of engine air intakes, beneath wing, each containing 2839 litres. Provision for up to three additional 2309 litre external fuel tanks. Max total internal and external fuel capacity 20,441 litres .

Accommodation

Pilot only, on McDonnell Douglas ACES II ejection seat. Stretched acrylic canopy and windscreen. Windscreen anti-icing valve by Dynasciences Corporation.

Avionics

General Electric automatic analogue flight control system standard. Hughes Aircraft AN/APG-63 X-band pulse Doppler radar (upgraded to AN/APG-70

under MSIP), equipped since 1980 with a Hughes Aircraft programmable signal processor, provides long-range detection and tracking of small high-speed targets operating at all altitudes to treetop level, and feeds accurate tracking information to the IBM CP-1075 96K (24K on early F-15C/Ds) central computer to ensure effective launch of the aircraft's missiles or the firing of its internal gun. For close-in dogfights, the radar acquires the target automatically and the steering/weapon system information is displayed on a McDonnell Douglas Electronics AN/AVQ-20 head-up display. A Teledyne Electronics AN/APX-101 IFF transponder informs ground stations and other suitably equipped aircraft that the F-15 is friendly. It also supplies data on the F-15's range, azimuth, altitude and identification to air traffic controllers. A Hazeltine AN/APX-76 IFF interrogator informs the pilot if an aircraft seen visually or on radar is friendly. A Litton reply evaluator for the IFF system operates with the AN/APX-76. A Honeywell vertical situation display set, using a cathode ray tube to present radar, electro-optical identification and attitude director indicator formats to the pilot, permits inputs received from the aircraft's sensors and the central computer to be visible to the pilot under any light conditions.

Armament

Provision for carriage and launch of a variety of air-to-air weapons over short and medium ranges, including four AIM-9L/M Sidewinders, four AIM-7F/M Sparrows or eight AIM-120 AMRAAM, and a 20mm M61A1 six-barrel gun with 940 rounds of ammunition. General Electric lead-computing gyro. A Dynamic Controls Corporation armament control system keeps the pilot informed of weapons status and provides for their management. Three air-to-surface weapon stations (five if configured with conformal fuel tanks) allow for the carriage of up to 10,705kg of bombs, rockets or additional ECM equipment. AN/AWG-20 armament control system.

Specifications

Dimensions External

Wing span	13.05m
Wing aspect ratio	3.01
Length	19.43m
Height	5.63m
Tailplane span	8.61m

Weights and Loadings

Weight empty[1]	12,973kg
Max fuel loads	
internal	6103kg
2 CFTs	4422.5kg
3 auxiliary tanks	5395.5kg
internal+external	15,921kg
Max takeoff weight (with CFTs)	30,845kg
Max wing loading	546.1 kg/m^2
Max power loading	147.87 kg/kN

Performance

Max level speed	>Mach 2.5
Service ceiling	18,300m
Ferry range	
with external tanks, no CFTs	>2500nm
with CFTs	3100nm
G limit	+9/-3
Max level speed	800 knots
Service ceiling	18,300m
Takeoff run	274m
Landing run	1067m
Max endurance	
with in-flight refuelling	15h
unrefuelled, with CFTs	5h 15 min

[1] No fuel, ammunition, pylons, or external stores.

Boeing (McDonnell Douglas) F-15E Eagle

USAF photo by Master Sgt. Joe Cupido

Type

Two-seat, dual role attack/air superiority fighter.

Programme

Demonstration of industry-funded Strike Eagle prototype (71-0291) modified from F-15B, including accurate blind weapons delivery, completed at Edwards AFB and Eglin AFB during 1982; product improvements tested in Strike Eagle, an F-15C and an F-15D between November 1982 and April 1983, including first take-off at 34019kg, 3175kg more than F-15C with conformal tanks; new weight included conformal tanks, three other external tanks and eight 500lb Mk 82 bombs; 16 different stores configurations tested, including 2000lb Mk 84 bombs, and BDU-38 and CBU-58 weapons delivered visually and by radar; full programme go-ahead announced 24 February 1984; first flight of first production F-15E (86-0183) 11 December 1986; first delivery to Luke AFB, Arizona, 12 April 1988; first delivery 29 December 1988 to 4th Wing at Seymour Johnson AFB, North Carolina.

Design Features

NACA 64A aerofoil section with conical camber on leading-edge; sweepback 38° 42' at quarter-chord; thickness/chord ratio 6.6% at root, 3% at tip; anhedral 1°; incidence 0°. Twin fins positioned to receive vortex off wing and maintain directional stability at high angles of attack. Straight two-dimensional external compression engine air inlet each side of fuselage. Air inlet controllers by Hamilton Standard. Air inlet actuators by National Water Lift. system capable of automatic coupled terrain following.

Landing Gear

Hydraulically retractable tricycle type, with single wheel on each unit. All units retract forward.

Power Plant

Initially, two Pratt & Whitney F100-PW-220 turbofans, each rated for take-off at 104.3kN, installed, with afterburning. Later aircraft have option of Pratt & Whitney F100-PW-229s or General Electric F110-GE-129s. USAF aircraft 135 onwards (90-0233), built from August 1991, have 129.4kN Pratt & Whitney F100-PW-229s, which also ordered for Saudi F-15S. Internal fuel in foam-filled structural wing tanks and six Goodyear fuselage tanks, total capacity 7643 litres.

Accommodation

Two crew, pilot and weapon systems officer, in tandem on McDonnell Douglas ACES II zero/zero ejection seats. Single-piece, upward-hinged, bird-resistant canopy.

Avionics

As F-15C/D, except triple redundant Lear Astronics digital flight control system with automatic terrain following standard. Hughes Aircraft AN/APG-70 I-band pulse Doppler radar provides full F-15C air-to-air capability plus high resolution synthetic aperture radar for air-to-ground; terrain-following capability provided by Martin Marietta AN/AAQ-13 LANTIRN navigation pod, and FLIR imagery displayed on Kaiser ID-2394/A wide field of view HUD; moving map display by Bendix/King RP-341/A remote map reader; IBM CP-1075C very high speed integrated circuit (VHSIC) central computer introduced in 1992, replacing CP-1075.

Armament

20mm M61A1 six-barrel gun in starboard wing-root, with 512 rds. General Electric lead computing gyro. Provision on underwing (one per wing) and centreline pylons for air-to-air and air-to-ground weapons and external fuel tanks. Wing pylons use standard rail and launchers for AIM-9 Sidewinder and AIM-120 AMRAAM air-to-air missiles; AIM-7 Sparrow and AIM-120 AMRAAM can be carried on ejection launchers on the fuselage or on tangential stores carriers on CFTs. Edo BRU-46/A and BRU-47/A adapters throughout, plus two LAU-106A/As each side of lower fuselage. F-15E can carry a wide variety and quantity of guided and unguided air-to-ground weapons.

Specifications

Dimensions (External)

Wing span	13.05m
Wing aspect ratio	3.01
Length	19.43m
Height	5.63m

Weights And Loadings[1]

Operating weight, empty[2]	14,515kg
Max weapon load	11,113kg
Max takeoff weight	36,741kg
Max wing load	650.50kg/m^2

Areas

Wing area, gross	56.5m^2

Performance

Max level speed at height	Mach 2.5
Max combat radius	685nm
Max range	2400nm
Max level speed	1434 knots

[1] F100-PW-220 engines

[2] No fuel, ammunition, pylons or external stores

Lockheed Martin (General Dynamics) F-16 Fighting Falcon

Type

Single- and two-seat multirole fighter.

USAF photo by Senior Airman Gary Guese

Programme

Emerged from Y F-16 of US Air Force Lightweight Fighter prototype programme 1972 (details under General Dynamics in 1977-78 and 1978-79 Jane's); first flight of prototype Y F-16 (72-01567) 2 February 1974; first flight of second prototype (72-01568) 9 May 1974; selected for full-scale development 13 January 1975; day fighter requirement extended to add air-to-ground capability with radar and all-weather navigation; production of six single-seat F-16As and two two-seat F-16Bs began July 1975; first flight of full-scale development aircraft 8 December 1976; first flight of F-16B 8 August 1977. Fleet of 3,300 F-16s achieved 5 millionth flying hour late in 1993 and 3,500th aircraft delivered 27 April 1995. Backlog of over 400 aircraft in 1996, plus anticipated orders for further 500 F-16s, expected to maintain production line in operation until 2005-10. F-16 air combat score was 69 for no losses, with three air forces, by mid-1996.

Under original procurement plan, final 12 F-16s for USAF ordered in FY94, but anticipated shortfall in fighter assets resulted in USAF considering plan to purchase 120 F-16C/Ds by 2010; initial batch of six included in FY96 budget, and similar quantity in FY97 requests, with further contracts expected.

Variants

F-16A. First production version for air-to-air and air-to-ground missions; production for USAF completed March 1985, but still available for other customers; international sales continue; powered since late 1988 (Block 15OCU) by P&W F100-PW-220 turbofan; Westinghouse AN/APG-66 range and angle track radar; first flight of first aircraft (78-0001) 7 August 1978; entered service with 388th TFW at Hill AFB, Utah, 6 January 1979; combat ready October 1980, when named Fighting Falcon; most now serving ANG and AFRES; power plants being upgraded to F100-PW-220E, between 1991 and 1996. In 1994, first AFRES F-16A/Bs gained BASE Terprom (terrain profile matching) software for ground collision avoidance. Also produced in Europe. Built in Blocks 01, 05, 10 and 15, of which Blocks 01 and 05 retrofitted to Block 10 standard 1982-84; Block 15 retrofitted to OCU standard from late 1987. First G F-16A ground trainers relegated to instructional use at 82nd Training Wing, Sheppard AFB, by 1993.

F-16B. Standard tandem two-seat version of F-16A; fully operational both cockpits; fuselage length unaltered; reduced fuel.

F-16C/D. Single-seat and two-seat USAF Multinational Staged Improvement Programme (MSIP) aircraft respectively, implemented February 1980. MSIP expands growth capability to allow for ground attack and beyond-visual-range missiles, and all-weather, night and day missions; Stage I applied to Block 15 F-16A/Bs delivered from November 1981 included wiring and structural changes to accommodate new systems; Stage II applied to Block 25 F-16C/Ds from July 1984 includes core avionics, cockpit and airframe changes. Stage III includes installation of systems as they become available, beginning 1987 and extending up to Block 50/52, including selected retrofits back to Block 25. Changes include Westinghouse AN/APG-68 multimode radar with improved range, resolution, more operating modes and better ECCM than AN/APG-66; advanced cockpit with upgraded interfaces and upfront controls, GEC-Marconi wide-angle HUD, two multifunction displays, Fairchild mission data transfer equipment and radar altimeter; expanded base of fin giving space for proposed later fitment of AN/ALQ-165 Airborne Self-Protection Jamming system (since cancelled); increased electrical power and cooling capacity; structural provision for increased take-off weight and manoeuvring limits; and MIL-STD-1760 weapons interface for use of smart weapons such as AIM-120A AMRAAM and AGM-65D IR Maverick. First AIM-120 operational launch (by any aircraft), 27 December 1992 F-16D (90-0778) of 33rd FS/363rd FW destroyed Iraqi MiG-25.

Common engine bay introduced at Block 30/32 (deliveries from July 1986) to allow fitting of either P&W F100-PW-220 (Block 32) or GE F110-GE-100 (Block 30) Alternate Fighter Engine. Other changes include computer memory expansion and seal-bonded fuselage fuel tanks. First USAF wing to use F-16C/Ds with F110 engines was 86th TFW at Ramstein AB, Germany, from October 1986. Additions in 1987 included full Level IV multitarget compatibility with AMRAAM (as Block 30B), voice message unit, Shrike anti-radiation missiles (from August), crash survivable flight data recorder and modular common inlet duct allowing full thrust from F110 at low airspeeds.

Design Features *(refers mainly to Block 40 F-16C/D)*

Cropped delta wings blended with fuselage, with highly swept vortex control strakes along fuselage forebody and joining wings to increase lift and improve directional stability at high angles of attack; wing section NACA 64A-204; leading-edge sweepback 40°; relaxed stability (rearward CG) to increase manoeuvrability; deep wing-roots increase rigidity, save 113kg structure weight and increase fuel volume; fixed geometry engine intake; pilot's ejection seat inclined 30° rearwards; single-piece birdproof forward canopy section; two ventral fins below wing trailing-edge. Baseline F-16 airframe life planned as 8,000 hours with average usage of 55.5% in air combat training, 20% ground attack and 24.5% general flying; structural strengthening programme for pre-Block 50 aircraft required during 1990s.

Landing Gear

Menasco hydraulically retractable type, nose unit retracting rearward and main units forward into fuselage. Nosewheel is located aft of intake to reduce the risk of foreign objects being thrown into the engine during ground operation, and rotates 90° during retraction to lie horizontally under engine air intake duct. Oleo-pneumatic struts in all units.

Power Plant

One 131.6kN (29,588lb st) General Electric F110-GE-129, or one 129.4kN Pratt & Whitney F100-PW-229 afterburning turbofan as alternative standard. These Increased Performance Engines (IPE) installed from late 1991 in Block 50 and Block 52 aircraft. Immediately prior standard was 128.9kN F110-GE-100 or 105.7kN F100-PW-220 in Blocks 40/42. Of 1,416 F-16Cs and F-16Ds ordered by USAF, 555 with F100 and 861 with F110. IPE variants have half share each in FY92 procurement of 48 F-16s for USAF, following eight reliability trial installations including six Block 30 aircraft which flew 2,400 hours between December 1990 and September 1992. F100s of ANG and AFRES F-16A/Bs upgraded to -220E standard from late 1991.

Accommodation

Pilot only in F-16C, in pressurised and air conditioned cockpit. McDonnell Douglas ACES II zero/zero ejection seat. Bubble canopy made of polycarbonate advanced plastics material. Inside of USAF F-16C/D canopy (and most Belgian, Danish, Netherlands and Norwegian F-16A/Bs) coated with gold film to dissipate radar energy. In conjunction with radar-absorbing materials in air intake, this reduces frontal radar signature by 40%. To enable the pilot to sustain high G forces, and for pilot comfort, the seat is inclined 30° aft and the heel line is raised. In normal operation the canopy is pivoted upward and aft by electrical power; the pilot is also able to unlatch the canopy manually and open it with a back-up handcrank. Emergency jettison is provided by explosive unlatching devices and two rockets. A limited displacement, force-sensing control stick is provided on the right-hand console, with a suitable armrest, to provide precise control inputs during combat manoeuvres.

The F-16D has two cockpits in tandem, equipped with all controls, displays, instruments, avionics and life support systems required to perform both training and combat missions. The layout of the F-16D second station is similar to the F-16C, and is fully systems-operational. A single-enclosure polycarbonate transparency, made in two pieces and spliced aft of the forward seat with a metal bow frame and lateral support member, provides outstanding view from both cockpits.

Avionics

Comms. Magnavox AN/ARC-164 UHF transceiver (AN/URC-126 Have Quick IIA in Block 50/52); provision for Magnavox KY-58 secure voice system; Collins AN/ARC-186 VHF AM/FM transceiver (AN/ARC-205 Have Sync Group A in Block 50/52), ARC-190 HF radio, government furnished AN/AIC-18/25 intercom and SCI advanced interference blanker, Teledyne Electronics AN/APX-101 IFF transponder with government furnished IFF control, government furnished National Security Agency KIT-1A/TSEC cryptographic equipment.

Radar. Westinghouse AN/APG-68(V) pulse Doppler range and angle track radar, with planar array in nose. Provides air-to-air modes for range-while-search, uplook search, velocity search, air combat, track-while-scan (10 targets), raid cluster resolution, single target track and (later) high PRF track to provide target illumination for AIM-7 missiles, plus air-to-surface modes for ground-mapping, Doppler beam-sharpening, ground moving target, sea target, fixed target track, target freeze after pop-up, beacon, and air-to-ground ranging. Proposed upgrade under study by Westinghouse and Lockheed Martin could provide full night/all-weather interdiction/close air support capability. Improved radar, currently designated as APG-68(I), will have synthetic aperture radar (SAR) mapping and terrain following (TF) modes and be integrated with a combined FLIR/laser designator, thus eliminating need for external targeting and navigation pods.

Flight. Litton LN-39 standard inertial navigation system (ring laser Litton LN-93 or Honeywell H-423in Block 50/52 and current FMS F-16A/BLN-93 for Egypt, Indonesia, Israel, South Korea, Pakistan, Portugal and Taiwan, plus Netherlands retrofit and Greek second batch); Collins AN/ARN-108 ILS, Collins AN/ARN-118 TACAN, Rockwell GPS, Honeywell central air data computer, General Dynamics enhanced stores management computer, Gould AN/APN-232 radar altimeter. BASE Terprom digital terrain system to be installed in all new USAF F-16s, USAF reserve F-16s and 301 European aircraft destined for MLU in first instance, but could be offered to FMS customers from 1996 on Block 20 F-16A/B aircraft. Optional equipment includes Collins VIR-130 VOR/ILS.

Instrumentation. GEC-Marconi wide-angle holographic electronic HUD with raster video capability (for LANTIRN) and integrated keyboard; data entry/cockpit interface and dedicated fault display by Litton Canada and Lockheed Martin; Astronautics cockpit/TV set.

Mission. Honeywell multifunction displays. Lockheed Martin LANTIRN package comprises AN/AAQ-13 (navigation) and AN/AAQ-14 (targeting) pods. Turkish aircraft (150+ to be modified by 1996) to share 60 LANTIRN pod systems; LANTIRN also purchased by Greece and South Korea and required for second Thailand batch. Enhanced capability LANTIRN incorporating second-generation FLIR tested by F-16 at Eglin AFB, early 1993. Sharpshooter pod (down-rated export version of AAQ-14 LANTIRN targeting system) acquired by Bahrain and Israel, but latter to get indigenous Rafael Litening IR targeting and navigation pod as replacement (initial fund-

ing already undertaken, with first delivery expected 1996). Pakistan F-16s carry Thomson-CSF Atlis laser designator pods. Singapore announced intention to purchase Lockheed Martin Sharpshooter in late 1995. Texas Instruments AN/ASQ-213 HARM Targeting System (HTS) pod carried by Block 50/52D aircraft.

Self-defence. Dalmo Victor AN/ALR-69 radar warning system replaced in USAF Block 50/52 by Loral AN/ALR-56M advanced RWR, which also ordered for USAF Block 40/42 retrofit and (first export) Korean Block 52s. Provision for Westinghouse AN/ALQ-131 or Raytheon AN/ALQ-184 jamming pods. AN/ALQ-131 supplied to Bahrain, Egypt, Netherlands and Pakistan. Taiwan to get 80 Raytheon AN/ALQ-184 (first export order and first foreign use). Israeli Air Force F-16s extensively modified with locally designed and manufactured equipment, as well as optional US equipment to tailor them to the IAF defence role. This includes Elisra SPS 3000 self-protection jamming equipment in enlarged spines of F-16D-30s and Elta EL/L-8240 ECM in third batch of F-16C/Ds, replacing Loral AN/ALQ-178(V)1 Rapport ECM in Israeli F-16As. Belgian F-16s have Dassault Electronique Carapace passive ECM system in fin-root housing on 100 aircraft (with some reserve systems) from April 1995 (to be used in conjunction with active AN/ALQ-131 jamming pods to be obtained from surplus US stocks).

Armament

General Electric M61A1 20mm multibarrel cannon in the port side wing/body fairing, equipped with a General Electric ammunition handling system and an enhanced envelope gunsight (part of the head-up display system) and 511 rounds of ammunition. There is a mounting for an air-to-air missile at each wingtip, one underfuselage centreline hardpoint, and six underwing hardpoints for additional stores. For manoeuvring flight at 5.5 G the underfuselage station is stressed for a load of up to 1,000kg, the two inboard underwing stations for 2,041kg each, the two centre underwing stations for 1,587kg each, the two outboard underwing stations for 318kg each, and the two wingtip stations for 193kg each. For manoeuvring flight at 9 G the underfuselage station is stressed for a load of up to 544kg, the two inboard underwing stations for 1,134kg each, the two centre underwing stations for 907kg each, the two outboard underwing stations for 204kg each, and the two wingtip stations for 193kg each. There are mounting provisions on each side of the inlet shoulder for the specific carriage of sensor pods (electro-optical, FLIR and so on); each of these stations is stressed for 408kg at 5.5G, and 250kg at 9G.

Typical stores loads can include two wingtip-mounted AIM-9L/M/P Sidewinders, with up to four more on the outer underwing stations; Rafael Python 3 on Israeli F-16s from early 1991; centreline GPU-5/A 30mm cannon; drop tanks on the inboard underwing and underfuselage stations; a Lockheed Martin Pave Penny laser spot tracker pod along the starboard side of the nacelle; and bombs, air-to-surface missiles or flare pods on the four inner underwing stations. Stores can be launched from Aircraft Hydro-

Forming MAU-12C/A bomb ejector racks, Hughes LAU-88 launchers, or Orgen triple or multiple ejector racks. Non-jettisonable centreline GPU-5/A 30mm gun pods on dedicated USAF ground-attack F-16As. Weapons launched successfully from F-16s, in addition to Sidewinders and AIM-120A AMRAAM, include radar-guided Sparrow and Sky Flash air-to-air missiles, British Aerospace ASRAAM and French Magic 2 infra-red homing air-to-air missiles, AGM-65A/B/D/G Maverick air-to-surface missiles, HARM and Shrike anti-radiation missiles, Harpoon anti-ship missiles (clearance trials 1993-94), and, in Royal Norwegian Air Force service, the Penguin Mk 3 anti-ship missile. Israeli TAAS STAR-1 anti-radiation weapon has also begun carriage trials on F-16D, although full-scale development is dependent upon receipt of a firm order.

Specifications

Dimensions External (F-16C, D)

Wing span	
over missile launchers	9.45m
over missiles	10.00m
Wing aspect ratio	3.2
Length	15.03m
Height	5.09m

Performance

Max level speed at 12,200m	> Mach 2.0
Service ceiling	> 15,240m
Ferry range, with drop tanks	> 2,100nm
Symmetrical G limit with full internal fuel	+9
Max level speed	1321 knots

Areas (F-16C, D)

Wing area, gross	27.87m^2

Weights and Loadings

Weight empty	
F-16C	
F100-PW-220	8,273kg
F110-GE-100	8,627kg
F-16D	
F100-PW-220	8,494kg
F110-GE-100	8,853kg
Max internal fuel	
F-16C	3,104kg
F-16D	2,567kg
Max takeoff weight	19,187kg

Lockheed/Boeing F-22 Raptor

Type

US Air Force next-generation tactical fighter, formerly known as Advanced Tactical Fighter (ATF) programme.

USAF photo by Technical Sgt. Lono Kollers

Programme

US Air Force ATF requirement for 750 (now 442) McDonnell Douglas F-15 Eagle replacements incorporating low observables technology and supercruise (supersonic cruise without afterburning); parallel assessment of two new power plants; request for information issued 1981; concept definition studies awarded September 1983 to Boeing, General Dynamics, Grumman, McDonnell Douglas, Northrop and Rockwell; requests for proposals issued September 1985; submissions received by 28 July 1986; USAF selection announced 31 October 1986 of demonstration/validation phase contractors Lockheed Y F-22 and Northrop Y F-23 (see 1991-92 Jane's); each produced two prototypes and ground-based avionics testbed; first flights of all four prototypes 1990. Competing engine demonstration/validation programmes launched September 1983; ground testing began 1986-87; flight-capable Pratt & Whitney Y F119s and General Electric Y F120s ordered early 1988; all four aircraft/engine combinations flown.

Lockheed teamed with General Dynamics (Fort Worth) and Boeing Military Airplanes to produce two Y F-22 prototypes, civil registrations N22YF (with GE Y F120) and N22YX (P&W Y F119); USAF serial numbers 87-0700 and 87-0701 assigned, but only 87-0701 applied during second phase of testing, from late 1991. N22YF rolled out at Palmdale 29 August 1990; first flight/ferry to Edwards AFB 29 September 1990; first air refuelling (11th sortie) 26 October 1990; thrust vectoring in flight 15 November 1990; anti-spin parachute for high angle of attack tests on 34th to 43rd sorties; flight testing temporarily suspended 28 December 1990; 43 sorties/52 hours 48 minutes. N22YX first flight Palmdale-Edwards 30 October 1990; AIM-9M Sidewinder (28 November 1990) and AIM-120A AMRAAM (20 December 1990) launch demonstrations; achieved Mach 1.8 on 26 December 1990; temporarily grounded after 31 sorties/38 hours 48 minutes, 28 December 1990. Flight test demonstrations included 100 deg/sec roll rate at 120 knots (222km/h) and supercruise flight in excess of Mach 1.58 without afterburner.

Second (F119-powered) Y F-22 taken by road to Palmdale mid-1991; fitted with strain gauges; began further 100 hour test programme 30 October 1991; gathered data on aerodynamic loads, flight control aerodynamic effects, vibration/acoustic fatigue and maximum coefficient of lift; flown by

6511th Test Squadron (F-22 Combined Test Force) of 6510th Test Wing at Edwards AFB; non-fatal crash landing at Edwards 25 April 1992, following pilot-induced oscillations; total 100 hours 24 minutes in 70 flights since October 1990; non-flyable, but repaired for use as antenna testbed at Rome Air Development Centre, Griffiss AFB, New York.

Fabrication of first component for first EMD aircraft (c/n 4001) began 8 December 1993 at Boeing's facility in Kent, Washington; assembly of forward fuselage launched at Marietta on 2 November 1995 with start of work on nose landing gear well; assembly work also begun at Fort Worth Summer 1995 with mating of three assemblies that comprise the mid-fuselage of first EMD aircraft taking place in Spring 1996, followed by road transfer of entire section to Marietta in August 1996 for start of final assembly process; first flight planned May 1997; low-rate production decision in August 1998; first production delivery August 2000; high-rate production decision due March 2002.

Design Features

Low observables configuration and construction; stealth/agility trade-off decided by design team; target thrust/weight ratio 1.4 (achieved ratio 1.2 at takeoff weight); greatly improved reliability and maintainability for high sortie-generation rates, including under 20 minute combat turnround time; enhanced survivability through 'first-look, first-shot, first-kill' capability; short takeoff and landing distances; supersonic cruise and maneuvering (supercruise) in region of Mach 1.5 without afterburning; internal weapons storage and generous internal fuel; conformal sensors.

Highly integrated avionics for single pilot operation and rapid reaction. Radar, RWR and comms/ident managed by single system presenting relevant data only, and with emissions controlled (passive to fully active) in stages, according to tactical situation. Common integrated processor (CIP) handles all avionics functions, including self-protection and radio, and automatically reconfigures to compensate for faults and failures. F-22 has two CIPs, with space for third, linked by 400 Mbits/s fibre optic network (see Avionics).

Wing and horizontal tail leading-edge sweep 42° (both 48° on Y F-22); trailing-edge 17° forward, increased to 42° outboard of ailerons (straight trailing-edge on Y F-22); all-moving five-edged horizontal tail (four-edged elements on Y F-22). Vertical tail surfaces (22% larger on Y F-22) canted outwards at 28°; leading- and trailing-edge sweep 22.9°; biconvex aerofoil. F-22's wing and stabilator areas same as Y F-22, despite reprofiling. F-22 wing taper ratio 0.169; leading-edge anhedral 3.25°; root twist 0.5°; tip twist -3.1°; thickness/chord ratio 5.92 at root, 4.29 at tip; custom-designed aerofoil. Horizontal tails have no dihedral or twist.

Sidewinder AAMs stored internally in sides of intake ducts, with AMRAAMs, Sidewinders or GBU-32 JDAM 1000 precision-guided munitions in ventral weapons bay. Diamond-shaped cheek air intakes with highly contoured air ducts; intakes approximately 0.46m farther forward on Y F-22; single-axis thrust vectoring included on PW119, but most specified performance achievable without.

Additional production F-22 changes from Y F-22 include decreased wingroot thickness, modified camber and twist (increasing anhedral); all 48° plan angles changed to 42°; blunter nose; wheelbase reduced by approximately 0.46m; wheel track reduced by same; revised undercarriage legs and doors; constant chord ailerons; reprofiled cockpit canopy; dorsal airbrake deleted.

Landing Gear

Menasco retractable tricycle type, stressed for no-flare landings of up to 3.05m/s. Nosewheel tyre 23.5 x 7.5-10; mainwheel tyres 37 x 11.5-18.

Power Plant

Two 155kN class Pratt & Whitney F119-PW-100 advanced technology reheated engines reportedly developed from F100 turbofan. Two-dimensional convergent/divergent exhaust nozzles with thrust vectoring for enhanced performance and maneuverability.

Accommodation

Pilot only, on zero/zero modified ACES II ejection seat and wearing tactical life support system with improved g-suits, pressure breathing and arm restraint. Pilot's view over nose is -15°.

Systems

Include Normalair-Garrett OBOGS, AlliedSignal APU and Smiths 270 V DC electrical distribution system.

Avionics

Final integration, as well as integration of entire suite with non-avionics systems, undertaken at F-22 Avionics Integration Laboratory, Seattle, Washington; airborne integration supported by Boeing 757 flying testbed; high-fidelity Full Mission Simulation (FMS) for integrated system Pilot-Vehicle Interface (PVI) evaluations, avionics development and mission effectiveness assessment.

Comms. TRW communications/navigation/identification system, including Mk 12 IFF.

Radar. Westinghouse/Texas Instruments AN/APG-77 electronically scanned radar (air-to-air and navigation).

Flight. TRW communications/navigation/identification subsystem; Litton inertial reference system.

Instrumentation. Fused situational awareness information is displayed to pilot via four Sanders/Kaiser colour liquid crystal multifunction displays (MFD); MFD bezel buttons provide pilot format control.

Mission. Hughes common integrated processor (CIP); CIP also contains mission software that uses tailorable mission planning data for sensor emitter management and multisensor fusion; mission-specific information delivered to system through Fairchild data transfer equipment that also contains mass storage for default data and air vehicle operational flight programme; stores management system. General purpose processing capacity of CIP is rated at more than 700 million instructions per second (Mips) with growth to 2,000 Mips; signal processing capacity greater than 20 billion operations per second (Bops) with expansion capability to 50 Bops; CIP contains more than 300 Mbytes of memory with growth potential to 650 Mbytes. Intra-flight data link automatically shares tactical information between two or more F-22s. Airframe contains provisions for IRST and side-mounted phased-array radar.

Self-defence. Sanders/General Electric AN/ALR-94 electronic warfare (RF warning and countermeasures) subsystem.

Armament

Internal long-barrel M61A2 20mm cannon with hinged muzzle cover and 480-round magazine capacity (production F-22). Three internal bays (see Design Features) for AIM-9 Sidewinder (one in each side bay) and/or four AIM-120A or six AIM-120C AMRAAM AAMs and/or GBU-32 JDAM 1000 PGMs on hydraulic weapon racks in main weapons bay. Four underwing stores stations at 317mm and 442mm from centreline of fuselage capable of carrying 2,268kg each.

Specifications

Dimensions External

Wing span	
YF-22	13.11m
F-22	13.56m
Length	
YF-22	19.56m
F-22	18.92m
Height	
YF-22	5.41m
F-22	5.05m

Areas

Wing area, gross	78.0m^2

Weights and Loadings[1]

Weight empty	
YF-22	> 13,608kg
F-22, target	14,365kg
Max takeoff weight	
F-22	almost 27,216kg

Performance[1]

Max level speed at 9,150m	
Supercruise	Mach 1.58
with afterburning	Mach 1.7
Service ceiling	15,240m
G limit	+7.9

Performance[2]

G limit	+9
Max takeoff weight	27216kg
Max level speed	1044 knots
at S/L	800kts

[1] YF-22 demonstated

[2] Estimated

McDonnell Douglas Phantom II F-4E

USAF photo

Type

Twin-engine, two-seat, all-weather fighter aircraft.

Programme

The Phantom II was developed initially as a twin-engine two-seat long-range all-weather attack fighter for service with the US Navy. A letter of intent to order two prototypes was issued 18 October 1954, at which time the aircraft was designated AH-1. The designation was changed to F4H-1 26 May 1955, with change of mission to missile fighter, and the prototype X F4H-1 flew for the first time 27 May 1958. The first production Phantom II was delivered to US Navy Squadron V F-101 in December 1960. Trials in a ground attack role led to USAF orders, and the basic USN and USAF versions became the F-4B and F-4C respectively.

Variants

F-4C (formerly F-110A). Version of F-4B for USAF, with J79-GE-15 turbojet engines, cartridge starting, wider tread low-pressure tyres size 30-11.5, larger brakes, Litton type LN-12A/B (ASN-48) inertial navigation system, APQ-100 radar, APQ-100 PPI scope, LADD timer, Lear Siegler AJB-7 bombing system, GAM-83 controls, dual controls and boom flight refuelling instead of drogue (receptacle in top of fuselage, aft of cockpit). Folding wings and arrester gear retained. For close support and attack duties with Tactical Air Command, PACAF and USAFE, and with the Air National Guard (ANG) from January 1972. Sufficient F-4Cs were modified to equip two squadrons for a defence suppression role under the USAF's Wild Weasel programme. These aircraft carry ECM warning sensors, jamming pods, chaff dispensers and anti-radiation missiles. First F-4C flew 27 May 1963; 36 supplied to Spanish Air Force. The last of 583 was delivered to TAC 4 May 1966. Replaced in production by F-4D.

F-4E. Multirole fighter for air superiority, close support and interdiction missions with USAF. Has internally mounted M-61A1 multibarrel gun, improved (AN/APQ-120) fire-control system and J79-GE-17 turbojet engines (each 79.6kN; 17,900lb st). Additional fuselage fuel cell. First production F-4E delivered to USAF 3 October 1967. Supplied to the Israeli Air Force, Hellenic Air Force, Turkish Air Force, Republic of Korea Air Force and Islamic Republic of Iran Air Force. All F-4Es fitted retrospectively with leading-edge maneuvering slats.

In early 1973 F-4Es began to be fitted with Northrop's Target Identification System Electro-Optical (TISEO). Essentially a vidicon TV camera with a zoom lens, it aids positive visual identification of airborne or ground targets at long range. The ASX-1 TISEO is mounted in a cylindrical housing on the leading-edge of the port wing of the F-4E.

F-4G. Development of F-4B for US Navy, with AN/ASW-21 datalink communications equipment, first flown 20 March 1963. In service over Vietnam with Squadron V F-213 from USS Kitty Hawk spring 1966. Only 12 built included in the total number of F-4B built. No longer in service.

F-4G (Wild Weasel). The USAF's Wild Weasel programme concerns primarily suppression of hostile weapon radar guidance systems. The provision of airborne equipment able to fulfill such a role, and modification of the necessary aircraft to create an effective force for deployment against such targets, had first priority in tactical air force planning spring 1975. The requirement for such a weapon system had been appreciated by Tactical Air Command as early as 1968, and feasibility studies were initiated September that year, following which, eight sets of equipment were acquired for development, qualification testing and flight testing in two F-4D aircraft. The F-4E however, was eventually chosen as the best aircraft on which to install the required equipment. Modifications include the addition of a torpedo-shaped fairing to the top of the tailfin to carry APR-38 antennae, with other APR-38 antennae installed on the side of the fin and along the upper surface of the fuselage. Other modifications include changes to the LCOSS amplifier in the upper equipment bay, APR-38 CIS installation in the aft cockpit, APR-38 CIS installation in the forward cockpit, removal of the M-61A1 gun system to allow sufficient room for installation of APR-38 subsystems (receiver, HAWC, CIS), and the provision of suitable cockpit displays. The changes give the F-4G Wild Weasel the capability to detect, identify and locate hostile electromagnetic emitters, and to deploy against them suitable weapons for their suppression or destruction. Such aircraft can operate independently in a hunter-killer role.

The USAF sought funding in FY76 for the advanced Wild Weasel concept for provision of an expanded memory of the airborne processor and extended low-frequency emission coverage. The programme provided for the first F-4G operational kit installation spring 1976 and the second autumn that year, followed by 15 installations in 1977, 60 in 1978 and 39 in 1979, to provide a force of 116 aircraft. USAF F-4G Wild Weasel were withdrawn by May 1996.

Design Features (F-4E)

Cantilever low-wing monoplane. Wing section NACA 0006.4-64 (mod) at root, NACA 0004-64 (mod) at wing fold line, NACA 0003-64 (mod) at tip. Average thickness/chord ratio 5.1%. Incidence 1°. Dihedral, inner panels 0°, outer panels 12°. Sweepback 45° on leading-edges. Outer panels have extended chord and dihedral of 12°.

Flying Controls

Trailing-edge is a one-piece aluminum honeycomb structure. Flaps and ailerons of all-metal construction, with aluminum honeycomb trailing-edges. Inset ailerons limited to down movement only, the "up" function being supplied by hydraulically operated spoilers on upper surface of each wing. Ailerons and spoilers fully powered by two independent hydraulic systems. Hydraulically operated trailing-edge maneuvering slats. Hydraulically operated airbrake under each wing aft of wheel well. Outer panels fold upward for stowage. Rudder interconnected with ailerons at low speeds.

Structure

Centre-section and centre wings form one-piece structure from wing fold to wing fold. Portion that passes through fuselage comprises a torsion box between the front and main spars (at 15% and 40% chord) and is sealed to form two integral fuel tanks. Spars are machined from large forgings. Centre wings also have forged rear spar. Centreline rib, wing-fold ribs, two intermediate ribs forward of main spar and two aft of main spar are also made from forgings. Wing skins machined from aluminum panels 0.635m thick, with integral stiffening. The fuselage is an all-metal semi-monocoque structure. Forward fuselage built in port and starboard halves, so that most internal wiring and finishing can be done before assembly. Keel and rear sections make use of steel and titanium. Double-wall construction under fuel tanks and for lower section of rear fuselage, with ram-air cooling. The tail unit is a cantilever all-metal structure, with 23° of anhedral on one-piece all-moving tailplane which has slotted leading-edges. Ribs and stringers of tailplane are of steel, skin titanium and trailing-edge of steel honeycomb.

Landing Gear

Hydraulically retractable tricycle type, mainwheels retracting inward into wings, nose unit rearward. Single wheel on each main unit, with tyres size 30-11.5 Type VIII; twin wheels on nose unit, which is steerable and self-centring and can be lengthened pneumatically to increase the aircraft's angle of attack for take-off. Brake-chute housed in fuselage tailcone. Mk II anti-skid system.

Power Plant

Two General Electric J79-GE-17A turbojet engines (each rated 79.6kN with afterburning). Variable area inlet ducts monitored by air data computer. Integral fuel tankage in wings, between front and main spars, and in seven fuselage tanks, with total capacity of 7,022 litres. Provision for one 2,270 litre external tank under fuselage and two 1,400 litre underwing tanks. Equipment for probe-and-drogue and "buddy tank" flight refuelling, with retractable probe in starboard side of fuselage. Oil capacity 39 litres.

Accommodation

Crew of two in tandem on Martin-Baker Mk H7 ejection seats, under individual rearward-hinged canopies. Optional dual controls.

Systems

Three independent hydraulic systems, each of 207 bars. Pneumatic system for canopy operation, nosewheel strut extension and ram-air turbine extension. Primary electrical source is AC generator. No battery.

Electronics And Equipment

CPK-92A/A24G-34 central air data computer; AN/ASQ-19(B) com-nav-ident; MS25447/MS25448 counting accelerometer; AN/APN-155 radar altimeter; AN/AJB-7 all-altitude bomb system; AN/ASN-46A navigational computer; AN/ASN-63 INS; AN/ASQ-91 (MOD) weapons release system, AN/ASG-26 (MOD) lead computing optical sight; AN/APR-36, -37 RHAWS;

AN/ASA-32 AFCS; AN/APQ-120 fire-control system radar; AN/ARW-77 AGM-12 control system; TD-709/AJB-7 sequential timer; ID-1755A standby attitude reference system; and KB-25A gunsight camera.

Armament

Four Falcon, Sparrow, Sidewinder, Shrike or Walleye missiles, or two Bullpup missiles, on four semi-submerged mountings under fuselage and four underwing mountings. Provision for carrying alternative loads of up to 7,250kg of nuclear or conventional bombs and stores on seven attachments under wings and fuselage. Stores which can be carried include B-28, -43, -57, -61 nuclear bombs; M117, M118, M129, MC-1, Mk 36, Mk 81, Mk 82, Mk 83 and Mk 84 bombs; MLU-10 land mine; BLU-1, -27, -52 and -76 fire bombs; cluster bombs; practice bombs; flares; rocket packs; ECM pods; gun pods; spray tanks; tow targets' Pave Knife pod; and AAVSIV camera pod. One M61A-1 nose-mounted gun. Iranian Air Force test-fired Chinese C-801 anti-ship cruise missiles in June 1997.

Specifications

Dimensions External

Wing span	11.77m
Length	19.200m
Height	5.020m

Weights and Loadings

Weight empty	13,757kg
Weight empty, basic mission	14,448kg
Takeoff weight	
combat	18,818kg
design	26,308kg
Max takeoff weight	28,030kg
Max landing weight	20,865kg
Max wing loading	569.2 kg/m^2
Max power loading	176.1 kg/kN

Performance[1]

Max level speed (with external stores)	> Mach 2.0
Average speed	
C	506 knots
E	496 knots
Stall speed, approach power w/BLC	
C	151 knots
E	158.6 knots

Performance[1] (cont.)

Max rate climb	2847m/min
at S/L	
C	2,621m
E	1,881m
at S/L one engine out	
C	1,591m
E	1,067m
Service ceiling	
C	10,620m
E	8,565m
Service ceiling, one engine out	
C	9,340m
E	6,490m
Takeoff run	
C	1,064m
E	1,338m
Landing run	1122.0m
Combat radius	
Area intercept	683nm
Defensive counter-air	429nm
Interdiction	618nm
Ferry range	1,718nm

[1] C at 25,397 kg, E at 28,030 kg

Mikoyan MiG-29 "Fulcrum"

detail from USAF photo

Type

All-weather single-seat counter-air fighter with attack capability, and two-seat combat trainer.

Programme

Technical assignment (operational requirement) issued 1972, to replace MiG-21, MiG-23, Su-15 and Su-17; initial order placed simultaneously; detail design began 1974; first of 14 prototypes built for factory and State testing flew 6 October 1977; photographed by US satellite, Ramenskoye flight test centre, November 1977 and given interim Western designation 'Ram-L'; second prototype flew June 1978; second and fourth prototypes lost through engine failures; after major design changes (see previous editions of Jane's) production began 1982, deliveries to Frontal Aviation 1984; operational early 1985; first detailed Western study possible after visit of demonstration team to Finland July 1986; production of basic MiG-29 combat aircraft by Moscow Aircraft Production Group (MAPO), and of MiG-29UB combat trainers at Nizhny Novgorod, for CIS air forces completed, but manufacture for export continues.

Design Features

All-swept low-wing configuration, with wide ogival wing leading-edge root extensions (LERX), lift-generating fuselage, twin tail fins carried on booms outboard of widely spaced engines with wedge intakes; doors in intakes, actuated by extension and compression of nosewheel leg, prevent ingestion of foreign objects during take-off and landing; gap between roof of each intake and skin of wingroot extension for boundary layer bleed; fire control and mission computers link radar with laser rangefinder and infrared search/track sensor, in conjunction with helmet-mounted target designator; radar able to track 10 targets simultaneously; targets can be approached and engaged without emission of detectable radar or radio signals; sustained turn rate much improved over earlier Soviet fighters; thrust/weight ratio better than one; allowable angles of attack at least 70% higher than previous fighters; difficult to get into stable flat spin, reluctant to enter normal spin, recovers as soon as controls released; wing leading-edge sweepback 73° 30' on LERX, 42° on outer panels; anhedral approx 2°; tail fins canted outward 6°; leading-edge sweep 47° 50' on fins, approx 50° on horizontal surfaces. Design flying life 2500 h.

Structure

Approx 7% of airframe, by weight, of composites; remainder metal, including aluminum-lithium alloys; trailing-edge wing flaps, ailerons and vertical tail surfaces of carbonfibre honeycomb; approx 65% of horizontal tail surfaces aluminum alloy, remainder carbonfibre; semi-monocoque all-metal fuselage, sharply tapered and downswept aft of flat-sided cockpit area, with ogival dielectric nosecone; small vortex generator each side of nose helps to overcome early tendency to aileron reversal at angles of attack above 25°; tail surfaces carried on slim booms alongside engine nacelles.

Landing Gear

Retractable tricycle type, made by Hydromash, with single wheel on each main unit and twin nosewheels. Mainwheels retract forward into wingroots, turning through 90° to lie flat above leg; nosewheels, on trailing-link oleo, retract rearward between engine air intakes. Hydraulic retraction and extension, with mechanical emergency release. Nosewheels steerable +/-8° for taxiing, takeoff and landings, +/-30° for slow speed manoeuvring in confined areas (selector in cockpit).

Power Plant

Two Klimov/Sarkisov RD-33 turbofans, each 49.4kN dry and 54.9-81.4kN with afterburning. Engine ducts canted at approx 9°, with wedge intakes, sweptback at approx 35°, under wingroot leading-edge extensions. Multi-segment ramp system, including top-hinged forward door (containing a large number of small holes) inside each intake that closes the duct while aircraft is taking off or landing, to prevent ingestion of foreign objects, ice or snow. Air is fed to each engine through louvres in top of wingroot leading-edge extension and perforations in duct closure door. Basic 'Fulcrum-A' has four integral fuel tanks in inboard portion of each wing and in fuselage between wings; total capacity 4365 litres.

Accommodation

Pilot only, on 10° inclined K-36DM zero/zero ejection seat, under rearward hinged transparent blister canopy in high-set cockpit. Sharply inclined one-piece curved windscreen. Three internal mirrors provide rearward view.

Avionics

RP-29 (N019 Sapfir-29) coherent pulse Doppler lookdown/shootdown engagement radar (NATO 'Slot Back'; search range 54nm, tracking range 38nm), target tracking limits 60° up, 38° down, 67° each side, collimated with laser rangefinder; infrared search/track sensor (fighter detection range 8nm) forward of windscreen (protected by removable fairing on non-operational flights); R-862 com radio; ARK-19 DF; inertial navigation system; SRO-2 (NATO 'Odd Rods') IFF transponder and SRZ-15 interrogator; Sirena-3 360° radar warning system, with sensors on wingroot extensions, wingtips and port fin. Two SO-69 ECM antennae under conformal dielectric fairings in leading-edge of each wingroot extension; head-up display; and helmet-mounted target designation system for off-axis aiming of air-to-air missiles.

Armament

Six close-range R-60MK (NATO AA-8 'Aphid') infrared air-to-air missiles, or four R-60MK and two medium-range radar guided R-27R1 (AA-10A 'Alamo-A'), on three pylons under each wing; alternative air combat weapons include R-73E (AA-11 'Archer') close-range infrared missiles. Able to carry FAB-250 bombs, KMGU-2 submunitions dispensers, 3B-500 napalm tanks, and 80mm, 130mm and 240mm rockets in attack role. One 30mm GSh-301 gun in port wingroot leading-edge extension, with 150 rds.

Specifications

Dimensions (External)

Wing span	11.36m
Wing aspect ratio	3.5
Length overall	
incl. noseprobe	17.32m
excl. noseprobe	16.28m
Height	4.73m
Tailplane span	7.78m

Weights and Loadings

Operating weight, empty	10,900kg
Max weapon load	3000kg
Max fuel load	640kg
Normal takeoff weight (interceptor)	15,240kg
Max takeoff weight	18,500kg
Max wing loading	486.8 kg/m^2
Max power loading	113.6 kg/kN

Performance

Max level speed	
at height	Mach 2.3
at S/L	Mach 1.06
Max rate of climb at S/L	19,800m/min
Service ceiling	17,000m
Range	
max internal fuel	810nm
with underbelly auxiliary tank	1133nm
G limit	
> Mach 0.85	+7
< Mach 0.85	+9
Takeoff run	250m
Landing run	600m

8 APPENDICES

Chapter 8

APPENDIX A: ACRONYMS AND ABBREVIATIONS

A/A	Air-to-Air
AAA	Anti-Aircraft Artillery
AB	Afterburner Capability; also Air Base
ACM	Air Combat Maneuvers
ACQ	Acquisition
ADC	Air Data Computer
ADI	Attitude Director Indicator
A/G	Air-to-Ground
AGL	Above Ground Level
AGM	Air to Ground Missile
ALT	Altitude
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AoA	Angle of Attack
ASL	Above Sea Level
AWACS	Airborne Warning And Control System
APC	Armored Personnel Carrier
AZ	Azimuth
BARO	Barometric
BFM	Basic Flight Maneuvers
BARCAP	Barrier Combat Air Patrol
BRAA	Bearing Range and Altitude (In AWACS messages)
BRG	Bearing
BVR	Beyond Visual Range
CAP	Combat Air Patrol
CAS	Close Air Support
CAVU	Clear and Visibility Unlimited (In weather section in briefs)
CBU	Cluster Bomb Unit
CCIP	Continuously Computed Impact Point
CDES	Continuous Designation
CFT	Conformal Fuel Tank
COMM	Communication
DLZ	Dynamic Launch Zone
DMZ	Demilitarized Zone
ECM	Electronic Countermeasures
EEGS	Enhanced Envelope Gun Sight
EWR	Early Warning Radar
FAC	Forward Air Controller
FLIR	Forward-Looking Infrared
FOV	Field of View
G	Gravity Force
GBU	Guided Bomb Unit (also known as a smart bomb)
HARM	High-speed Anti-Radiation Missile
HSI	Horizontal Situation Indicator
HOTAS	Hands on Throttle and Stick
HUD	Head-Up Display
Hz	Hertz, cycles per second
HVAA	High Value Airborne Asset
IFF	Identification Friend or Foe
ILS	Instrument Landing System
INS	Inertial Navigation System
IR	Infrared
JTIDS	Joint Tactical Information Distribution System
JSTARS	Joint Surveillance Target Attack Radar System

KTAS	True Airspeed in Knots
LANTIRN	Low Altitude Navigation and Targeting, Infrared, for Night
LGB	Laser-Guided Bomb
LOS	Line of Sight
MFD	Multi-Function Display
MRM	Medium Range Missile
NOE	Nap-of-Earth
NM	Nautical Mile
RCS	Radar Cross Section
ROE	Rules of Engagement
RWR	Radar Warning Receiver
RWS	Range While Search
SAM	Surface-to-Air Missile
SARH	Semi-Active Radar Homing
SEAD	Suppression of Enemy Air Defense
SMS	Stored Management System
SRM	Short Range Missile
STT	Single Target Track
TACAN	Tactical Aid to Navigation
TAS	True Airspeed
TCN	TACAN
TOF	Time of Flight
TOT	Time on Target
TWS	Track While Scan
VID	Visual Identification
VSI	Vertical Speed Indicator
WEZ	Weapon Employment Zone or DLZ (delivery zone — also known as the weapon envelope)
WSO	Weapons Systems Officer

APPENDIX B: GLOSSARY OF TERMS

*Additional definitions can be found in **Aircraft: Definitions**, p. 7.1.*

Active. A radar missile currently using a self-guidance system to locate its target.

Airfoil. Curved wing or blade surface designed to produce lift when air passes over it.

Airframe. Basic construction of the aircraft (doors, landing gear, seats, cabin, etc.).

Angels. Altitude in thousands of feet. "Angels ten" indicates altitude 10,000ft.

Angle of Attack (AoA). Aerodynamic angle formed between the chord of an airfoil and the direction of the relative wind.

Aspect Angle. Angle from which a target is viewed — the number multiplied by 10. "9R" means a view of the target's right wing from a 90° angle.

Attitude. Pitch angle of the aircraft's nose, relative to the horizon.

Attitude Director Indicator. Shows attitude of airplane relative to horizon.

Azimuth. Indicates a position on a horizontal plane surrounding your aircraft.

Bandit. Confirmed enemy aircraft.

Barometric Altitude. Altitude above sea level, calculated from air pressure data.

Barrage Fire. Anti-aircraft fire that "floods" an area with ammunition rather than trying to specifically target and hit an aircraft.

Bent. An informative call indicating the identified equipment is inoperative.

Bingo. When your aircraft has just enough fuel to get back to base and land.

Blind. An informative call indicating loss of visual contact with friendly aircraft.

Bogey. Unidentified aircraft (radar or visual contact).

Bogey Dope. A request for target information from GCI/AWACS

Boomer. Boom operator of an mid-air refueling tanker (such as a KC-135).

Bracket. Fighter element attack geometry which places aircraft on opposing sides of the target either laterally or vertically.

Break (Up/Down/Right/Left). A directive call to perform an immediate maximum performance defensive turn in the direction indicated.

Buddy Spike (position/azimuth/altitude). An informative call indicating reception of friendly AI RWR.

Bullseye. Code word for a specific reference point from which the position of target aircraft are determined.

Captured. Condition of a target that has been locked onto by the laser tracker.

Chaff. Strips of metal film released to confuse and decoy radar-guided weapons.

Chord. Imaginary line that passes through the leading and trailing edges of an airfoil. See "Angle of Attack."

Closing. Range to the bandit/bogey/target is decreasing.

Contact. Radar lock on target.

Closure. Relative velocity of one aircraft in relation to another.

Corner Speed/Velocity. Minimum airspeed at which the maximum allowable aircraft G is generated. i.e., speed at which an aircraft can turn the sharpest, given current altitude and attitude.

Designate. Use of aircraft systems to identify a ground objective/aircraft as a target for weapons employment.

Drag. Force that counteracts an object in motion through the air, such as air resistance.

Echelon. A call conveying groups/contacts/formation with wingmen placed 45° behind the leader's wingline.

Egress. Outbound (exit) portion of an A/G attack profile.

Element. A flight of two aircraft.

Fox 1. Radio call for short range radar missile launch.

Fox 2. Radio call for IR missile launch.

Fox 3. Radio call for AIM-120 AMRAAM missile launch.

Flare. Pyrotechnic device dispensed to defeat IR missiles.

Frag. Fragmentary range and duration of a weapon.

Furball. Turning fight with many aircraft.

Guns. Air-to-air or air-to-surface gunshot.

Heater. A slang term for an IR missile.

Hot (Air-to-Air). 1. An informative GCI call — the target is heading toward your fighter; 2. Intercept geometry that positions your fighter in front of an enemy target; 3. Leg of a CAP flight that is heading toward the anticipated threats.

Hot (Air-to-Ground). The use of ordnance is authorized, anticipated, or completed.

Hung. An A/A or A/G weapon has been electronically launched/released, but ordnance remains on hardpoint.

Indicated Airspeed. The speed you would be traveling (given engine performance) at sea level in still air. An aircraft flying at the same true airspeed will show different indicated airspeeds at different altitudes and under different wind conditions.

Ingress. Inbound (entry) portion of an A/G attack profile.

Interleaved. Radar search mode alternating medium and high PRF waveforms.

Initial Point. The location at which aircraft turn to directly approach a target — the waypoint just prior to a target point.

Jammer. Electronic countermeasure that emits microwaves to distort/confuse enemy radarscopes.

Jink. Sharp turns in order to avoid gun fire.

Knot. Measure of speed equal to one nautical mile per hour. (See Nautical Mile.)

Lag Pursuit. Refers to pointing an aircraft's nose just behind an enemy's flight path during a turn.

Lead Pursuit. Refers to pointing an aircraft's nose just ahead of an enemy's flight path during a turn.

Line. A call conveying groups/contacts/formation with wingmen placed off of the leader's right wing (3 o'clock position) or left wing (9 o'clock position).

Mach. Speed of sound at sea level (760ft/s) used to measure rapid flight (Mach 1, Mach 2, etc.).

Mach Ratio. Ratio of an aircraft's speed to the speed of sound at the same altitude.

Magnum. Radio call for AGM-65 Maverick launch.

Mark-20. Canister bomb containing bomblets; used against armored targets.

Mark-82. 500lb general-purpose bomb.

Mark-84. 2000lb general-purpose bomb.

Maverick. Nickname for the AGM-65 TV-guided missile.

MiG. Common nickname for the Soviet designed fighter aircraft.

Mil Power. Maximum aircraft power, not using afterburner.

Mud Spike. An enemy ground radar warning on the RWR.

No Joy. No visual contact has been made with the enemy.

Nautical Mile. Aeronautical measurement of distance equal to 6,076ft.

Ordnance. Military weapons — including expendable armament, such as missiles and ammunition.

Padlocked. An informative call indicating the aircrew cannot take their eyes off the target without a significant risk of losing tally (lock).

Patch Map. Radar image used in targeting.

Pickle. To press weapon release button.

Pipper. Visual aiming designator that appears on the HUD.

Point of Impact. Point along the leading edge of an airfoil where the air separates and flows over the top and bottom of the airfoil.

Radar Altitude. Altitude above ground level (AGL), in feet, calculated from terrain-following radar returns.

Radar Signature. Measure of an aircraft's visibility to radar; also called its radar cross section (RCS).

Rockeye. See Mark-20.

Roland. (French) Surface-to-Air missile; effective at low altitudes.

SAM ring. A circle designating the outer range of a SAM's threat to overhead aircraft.

Sanitize. A directive call to clear an assigned area with the radar searching for additional threats.

Scissors. Defensive maneuvering utilizing a succession of turn reversals attempting to achieve an offensive posture following an attacker's overshoot.

Scramble. Launch the aircraft as soon as possible.

Scud. Tactical surface-to-surface ballistic missile, medium-range, modified and used by Iraq.

Semi-Active. A missile/bomb guidance system in which the missile receiver homes in on radiation/reflection from the target that has been scanned by a source other than the missile itself. For example, another aircraft can bounce radar off the target, and help the missile home in on the target.

Sequence Points. A set of geographical points to be overflown, including steer points, initial points, and target points. Also known as waypoints.

Sideslip. Tendency of an aircraft to "slide" through a turn due to its forward motion. The nose is pointed slightly sideways relative to the direction of flight.

Sidewinder. An AIM-9 IR missile

Sparrow. An AIM-7 semi-active radar missile.

Spike. Enemy air intercept radar warning on the RWR.

Stall. "Loss of lift" that occurs when the angle of attack is too steep or airspeed is too low for the airfoil to provide any lift. During a stall, the normally streamlined flow of air over the airfoil is disrupted.

Straight Flush. Acquisition radar unit for SA-6 Surface-to-Air missiles.

Sweep. Patrol in enemy territory, intended to search and destroy enemy aircraft.

Tally. An informative call conveying visual contact with the bandit, the opposite of "No Joy."

Tankplink. Attack armored vehicles using laser-guided bombs.

Target Point. A steer point at which a pilot releases weapons.

Trailer. The last aircraft in a formation.

Trail. A call the conveys groups/contacts/formation with wingmen flying behind the leader (6 o'clock position).

Triple-A. Unguided, ground-to-air gunfire (12.7—100mm).

True Airspeed. Velocity relative to the ground, taking into account additions and subtractions to your indicated airspeed due to altitude, temperature, wind direction and speed, side slippage, etc.

Turn Rate. Degrees/second an aircraft can turn. The higher the rate, the faster the turn.

Turn Radius. Radial distance required to complete a turn. The smaller the radius, the tighter the turn.

Weapon Envelope. Effective area of attack for a weapon. Enemies in this envelope are vulnerable to weapon's fire.

Wedge. A call conveying groups/contacts/formation with wingmen flying 45 degrees off the leader's wing, with wingmen on either side of the leader.

Wilco. Will comply.

Wild Weasel. Aircraft (F-4Gs in Gulf War) that take out SAM sites in preparation for strike attacks.

APPENDIX C: CREDITS

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Terrain Data

8 meter data: ©1999 CNES, Licensed by SPOT Image Corp., Reston, VA.

AVHRR 1km data and Final Color Processing: The Living Earth, Inc. - livingearth.com

TM Data available from U.S. Geological Survey, EROS Data Center, Sioux Falls, SD

Satellite Image Processing and Data Fusion: ImageLinks, a division of AGIS, Inc. www.imagelinks.com

Maps: Charts ONC F-02, TPC F-02A/B, ONC G-04, TPC G-04B, ONC G-18, TPC G-18B/C, ONC G-19, TPC G-19A/D, ONC H-22, TPC H-22A/B, ONC J-10, ONC J-11, TPC J-11A/D, ONC K-09, ONC K-10, TPC K-10A/B/D products of the National Imagery and Mapping Agency. ©Crown Copyright/MOD. Maps ONC E-02, TPC E-02C, ONC H-05, TPC H-05B, ONC H-06, TPC H-06A reproduced with permission of the Controller of Her Britannic Majesty's Stationary Office

Special Thanks

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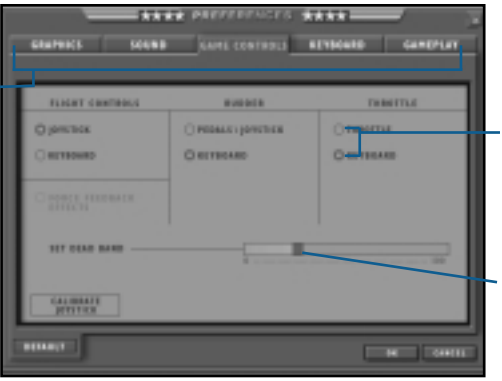
APPENDIX D: PREFERENCES WINDOW

You adjust game preferences with the *Preference* window. You can open this window in one of three ways:

- To open the *Preferences* window from the Main Menu screen, click the **PREFERENCES** button in the lower right corner.
- To open the *Preferences* window from any other interface screen, click on the **MENU** button at the bottom and choose **PREFERENCES**.
- Press Ctrl O to open the *On the Fly* menu. Then, left-click the **PREFERENCES** button to open the *Preferences* window during flight.



Click the tabs to select one of the following panels:

GRAPHICS	Set graphics preferences.
SOUND	Set sound preferences.
GAME CONTROLS	Choose the game controls you want to use for flight and calibrate your joysticks.
KEYBOARD	Remap keyboard and customize voice commands.
GAMEPLAY	Adjust gameplay options and difficulty levels.

Click the buttons below to reset to default settings or to close the window. Gameplay settings are set according to the gameplay level you select when installing the game. The default graphics settings are determined by your specific platform (type of system).

DEFAULT	Reset the current tab to its default settings.
OK	Close the *Preferences* window, accepting all changes.
CANCEL	Close the *Preferences* window without accepting any changes.

Graphics Panel

The **GRAPHICS LEVEL** option appears at the top of the *Graphics* panel, followed by five radio buttons — LOW, MEDIUM, HIGH, EXTRA and CUSTOM.

Click LOW, MEDIUM or HIGH to set your overall graphics settings. These settings turn various graphic settings on or off, and reset graphic detail levels accordingly.

LOW Minimize graphic detail and maximize game performance.

MEDIUM Set medium graphic detail (may slow down game performance on a lower-end system).

HIGH Maximize graphic detail (may slow down game performance on lower-end systems).

EXTRA Select settings specific to an Intel *Pentium™ III*. This option is grayed out unless you've installed the game on an Intel *Pentium III* computer.

CUSTOM Set individual graphics settings. See **Customizing Graphics Settings**, below.

Customizing Graphics Settings

Choose CUSTOM as your **GRAPHICS LEVEL** (see above). Then, click the tabs along the left side of the *Graphics* panel to customize different options.

Display Tab

Set resolutions for in-flight screens. Lower resolutions speed up game performance, while higher resolutions slow down game performance.

DISPLAY RESOLUTION. The available resolutions differ, depending on which graphic card you've selected. Choose a resolution for interface screens (i.e., all non-cockpit screens) from the pull-down menu — for example, 800x600x16 or 1152x864x16.*

* The x16 refers to 16-bit color. Some cards may support 32-bit color.

Terrain Tab

Set terrain detail levels. Lower levels speed up game performance; higher levels slow down game performance.

- Click-and-drag the slider bars to raise and lower levels — the longer the orange bar, the higher the level.

TERRAIN TEXTURE QUALITY. Determines the sharpness and detail of the terrain texture — i.e., the grass, dirt, gravel, etc. effects.

TERRAIN COMPLEXITY. Determines the complexity of the actual terrain features — for example, whether a rocky hill is simple and smooth, or jagged and rough. The highest setting is enabled for an Intel *Pentium™ III* processor.

TERRAIN MULTITEXTURE. When checked, applies extra texture details to terrain to give you a better sense of high-speed flight. (Some cards may not support this feature.)

Objects Tab

- Click-and-drag the slider bars to raise and lower levels — the longer the orange bar, the higher the level. Lower levels speed up game performance; higher levels slow down game performance.
- Click to place or remove a check mark in the boxes. Checking items increases detail but slows down game performance; unchecking items decreases detail but speeds up game performance.

OBJECT DETAIL. Controls how detailed objects are. The highest setting is enabled for an Intel *Pentium III* processor.

CULTURAL OBJECTS DENSITY. Controls how many non-mission element objects populate the mission world. The highest setting is enabled for an Intel *Pentium III* processor.

EXTERNAL LOADOUT. When checked, all aircraft's external stores are visible (i.e., missiles, bombs, fuel tanks, etc. loaded on external hardpoints).

OBJECTS MIP-MAP. When checked, object resolution and detail decreases as the object gets further away. This speeds up game performance without noticeably detracting from your perception of detail. It mimics the way your eyes work — you see less detail as objects get further away.

Effects Tab

This panel toggles different graphical effects on and off. In general, the more effects you turn on, the greater the realism in the mission world, but the slower the game performance. Some effects also impact visibility during a mission. For this reason, you may want to turn them on or off.

- Slider bars and check boxes work as described under **Objects Tab**, above.

EFFECT LEVEL. Changes the extent of graphics effects — for example, raising this setting extends lighting effects toward terrain and objects that are further away. The highest setting is enabled for an Intel *Pentium III* processor.

3D CLOUD LEVEL. Controls the level of cloud detail. When the setting is high, clouds are more three-dimensional. The highest setting is enabled for an Intel *Pentium III* processor.

SHADOWS. When checked, shadows become visible.

ENVIRONMENT ILLUMINATION. When checked, lighting effects (such as muzzle flashes and explosions) cast light on nearby terrain features.

OBJECT ILLUMINATION. When checked, lighting effects (such as muzzle flashes and explosions) cast shadows on nearby objects.

SPECULAR HIGHLIGHT. When checked, objects shine when lit.

BILINIAR FILTERING. When checked, the computer samples only two points when creating color averages, and objects and terrain are a bit blotchy.

TRILINIAR FILTERING. When checked, the display changes smoothly between texture qualities, producing cleaner objects and terrain and better blending. Some cards may not support triliniar filtering.

Sound Panel

Use the sound panel to set volumes for background music and ambient sounds.

- Click-and-drag the slider bars to raise and lower volume levels — the longer the orange bar, the higher the level.

MASTER VOLUME SLIDER. Controls volume for all music and sounds in the game. To mute all sound, click the MUTE box to place a check mark in it. Uncheck the MUTE box to un-mute sound.

BACKGROUND MUSIC VOLUME. Controls volume for the background music.

ENGINE VOLUME. Controls volume of your aircraft's engine.

SOUND EFFECTS VOLUME. Controls volume of other game sound effects, such as avionics returns, missile flight and explosions.

SPEECH VOLUME. Controls volume of in-flight communications.

Game Controls Panel

Use the game controls panel to choose flight control devices. (On interface screens, you will always use the keyboard and/or mouse.) See **Flight: Flight Controls**, p. 3.8, for more information on controlling flight.

Flight Controls

Set your flight control device (i.e., the equivalent to a pilot's flight stick, which gives pitch and roll inputs) to either JOYSTICK or KEYBOARD.

- You can only use the JOYSTICK option if you have a joystick set up and calibrated under *Windows 95/98®*.
- The default flight control key commands are ↑, ↓, ←, and →.

Rudder

Choose your rudder device, either PEDALS, JOYSTICK or KEYBOARD.

- You can only use the PEDALS/JOYSTICK option if you have rudder pedals or a joystick feature that supports rudder control (such as *Microsoft's® Sidewinder Pro™*). See your *Reference Card* for more details. You must set up and calibrate this device under *Windows 95/98* before the game can recognize it.
- The default rudder key commands are Numpad 0 and Numpad .

Throttle

Choose your throttle device, either JOYSTICK THROTTLE or KEYBOARD.

- You can only use the JOYSTICK THROTTLE option if you have a separate throttle device, or a throttle wheel or slider on your joystick. You must set up and calibrate this device under *Windows 95/98* before the game can recognize it.
- The default throttle key commands are 0 - 9.

Calibrate Joystick

Click this button to open the *Windows 95/98 Game Controllers* calibration window. (*Jane's USAF* remains active in the background.)

Follow these steps to calibrate your joystick through this window:

1. Double-click on your joystick in the list of **Game Controllers**.
2. Click on the **Settings** tab in the window that appears.
   - If the joystick has a rudder device (or rudder pedals attached to it), click to place a check mark in the box under **Rudder.**
3. Click the **Calibrate** button.
   - Follow the directions onscreen to move through the calibration wizard. Click NEXT to move forward a step and BACK to move backward a step.
4. Click on the **Test** tab.
   - Move your joystick around in circles to make sure it moves all the way to each edge of the white **Axes** box.
   - Click each button on your joystick to test it.
5. Once you're satisfied with the calibration, click **Apply**, then click **OK**. Otherwise, repeat Step 2 to re-calibrate.
6. Click the **Jane's USAF** button on the *Windows* taskbar at the bottom of the *Windows 95/98* screen to return to the game.

Note: *Joysticks vary greatly — please refer to the manufacturer's documentation if you are having difficulty setting it up and calibrating it in* Windows 95/98.

Force Feedback Effects

This option is available only if you're using a *force feedback* joystick you set up and calibrated through *Windows 95/98*. These joysticks have small motors that duplicate forces a pilot feels when banking, pulling up, etc.

- Click on the radio dot next to FORCE FEEDBACK EFFECTS to select this option.

Set Dead Band

A joystick's *dead band* is the percentage of distance between the joystick's centered position and its outer range of motion, where it doesn't recognize inputs. If you know this percentage, click-and-drag the slider bar to that amount.

You can use this option in addition to (or in place of) the CALIBRATE JOYSTICK button. See **Calibrate Joystick,** above.

Keyboard Panel

Use the *Keyboard* panel to remap keyboard commands and joystick buttons, or to change voice commands.

Note: *Microsoft's Speech Recognition Engine must be installed and active in order for you to use voice commands. When installing the game, you'll be asked if you want to use voice commands. Please see the printed* Install Guide *for a list of voice commands.*

Changing a Keyboard Assignment

1. Click *once* on the command to highlight it.
2. Press the new key.
   - If this key is currently assigned to another command, a dialogue box appears, asking if you want to use the new key setting.
   - Click **NO** to lose the new key setting or click **YES** to confirm the new key setting. (The two keys switch definitions.)
   - There is no way to delete a key assignment (unless you press the **DEFAULT** button, which changes all assignments to their defaults). To change a key assignment, follow Steps 1-2 above.

Changing a Joystick Button Assignment

1. Click *once* on the command to highlight it.
2. Press the new joystick button.
   - If that joystick button is currently assigned to another command, the old assignment is deleted and the joystick button is re-assigned to the new command.

Changing a Voice Command

1. Double-click on the voice command to highlight it.
2. Type a new command in the window that appears. You may divide the speech command into two phrases — Phrase 1 and Phrase 2. We recommend using two separate phrases when you have many similar voice commands. This makes the recognition engine more accurate.
   - Click **CANCEL** to close the window without saving the new voice command or click **OK** to close the window and save the new voice command.

Gameplay Panel

Use the *Gameplay* panel to change the difficulty level of the game. The **GAMEPLAY LEVEL** option appears at the top of the *Gameplay* panel and is followed by five radio buttons: CHEAT, EASY, NORMAL, REALISTIC and CUSTOM.

- **CHEAT** Set player skill requirements and enemy AI to their lowest levels, *and* activate cheats. When you select cheat options, points are deducted from your score accordingly.
- **EASY** Set player skill requirements and enemy AI to their lowest levels, but do *not* activate cheats.
- **NORMAL** Set player skill requirements and enemy AI to medium levels.
- **REALISTIC** Set player skill requirements and enemy AI to their highest levels. Choose this for maximum realism.
- **CUSTOM** Set individual gameplay settings yourself. See **Customizing Gameplay Settings**, on the following page.

Customizing Gameplay Settings

Click on the tabs to view different categories, then click on the radio buttons or check boxes next to options to select/deselect them. A dot or check mark appears by options that are selected.

Player Skills Tab

NO BLACKOUTS. Prevent the screen from turning red or black when you exceed G-levels, or G-force readings higher than what a normal pilot can tolerate.

EASY LANDINGS. Make landings easier. (This allows you to fly in at slightly higher speeds, a less than optimum angle, etc., and still land safely).

EASY AIMING. Enlarge the air-to-air missile envelope. You do not have to be in the weapon's exact kill zone for the missile to hit.

EASY TARGETING. Maintain your lock on a target when it moves out of your view.

BASIC FLIGHT MODEL. Switch to an easier flight model (i.e., it's very hard to enter a stall or spin).

Enemy Level Tab

ROOKIE AI. Set enemy AI to its lowest level — enemies are more likely to miss you, wait until you are well within range before firing, etc.

NORMAL AI. Set enemy AI to an average level.

EXPERT AI. Set enemy AI to its highest level — enemies are more likely to hit you, target you at longer ranges and continue to press attack, attempt more risky maneuvers, etc.

Cheats Tab

INVULNERABLE. You cannot be killed.

NO CRASHES. You cannot collide with anything (objects in midair, terrain features, the ground, etc.)

NO MALFUNCTIONS. Your aircraft does not incur damage. You can die once you have been hit enough times (or when you crash); however, none of your systems suffer the normal malfunctions caused by damage up until the point that you die.

UNLIMITED AMMO. You never run out of ammunition.

UNLIMITED FUEL. Your aircraft's fuel supply never runs out.

ENABLE CHEAT RADAR. You can use the AA and AG radar cheat submodes (the aircraft's radar displays threats in a 360° area around your aircraft).

Others Tab

FULL WAYPOINT NAME ON TERRAIN. Display waypoint name next to its icon on HUD.

OBJECT ID ON TD BOX. Display a targeted object's type beneath the TD box (for example "MiG-29"). In multiplayer games, a callsign also displays if a player is the target.

MENU TOOL TIPS. Display small pop-up definitions that appear when you move the mouse over an interactive screen element.

REALISTIC HEAD MOVEMENT RESTRICTION. You can only pan the 3D cockpit view (the F2 view) as far as you can turn your head (approximately 150° left and right).